



Oregon

Kate Brown, Governor

Department of Environmental Quality

Northwest Region

700 NE Multnomah Street Suite 600

Portland, OR 97232

(503) 229-5263

FAX (503) 229-6945

TTY 711

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Todd Slater
Legacy Site Services LLC
486 Thomas Jones Way, Suite 110
Exton, PA 19341-2528

Subject: DEQ Final Modification "Revised Upland Feasibility Study Work Plan"
Arkema Facility
ECSI #

Dear Mr. Slater:

The Oregon Department of Environmental Quality (DEQ) received the *Revised Upland Feasibility Study Work Plan* (Revised FS Work Plan) dated November, 2017. The report was prepared by Environmental Resources Management (ERM) for Legacy Site Services LLC (LSS).

The *Revised FS Work Plan* is a revision of the FS Work Plan addressing DEQ's requested modifications as presented in DEQ's April 7, 2017 review of the July 2013 *Draft Upland Feasibility Study Work Plan and Revised Hot Spot Evaluation*. The *Revised FS Work Plan* does not fully address our April 7, 2017 directed modifications through either omission, refusal, or error as indicated below.

Therefore, consistent with Section K(5) of the Consent Order, DEQ has modified the deliverable to address the deficiencies identified below. A redlined version of the Work Plan is included as Attachment 1. Attachment 2 addresses LSS's Response Table that provided directed responses to each of DEQ's April 7, 2017 comments.

As part of DEQ's modification, the Preliminary Hot Spot Evaluation, which was included as an Attachment to the Work Plan, is rejected in whole. Due to numerous errors and failure to implement DEQ's directed changes substantial revision of the PRHE is needed. DEQ will provide review comments and directed modifications separately.

The FS Work Plan is approved as modified in this letter and provided in Attachment 1.

General Comments

1. The Feasibility Study must be based on the current data set as previously directed by DEQ and most recently in our April 7, 2017 General HS Comment 5; and specific comments 4, 30, 31, 32, and 35.

For groundwater this means the Feasibility Study and Preliminary Hot Spot Evaluation must be based on the maximum detected contaminant concentrations in the specified groundwater data sets generated by LSS and Rhone-Poulenc. DEQ has modified the FS Work Plan to be consistent with these earlier directions on data use.

2. The Feasibility Study must be based on the Preliminary Numeric Remedial Action Objectives (i.e. Preliminary Remedial Goals) as previously directed by DEQ and most recently in our April 7, 2017 General HHRA 1, specific comment 21, 64, and 80.

DEQ has determined the Preliminary Numerical RAOs are appropriate values to serve as target levels during the development, analysis and selection of cleanup alternatives. These values are typically identified as Preliminary Remedial Goals (PRGs). The FS must be based on the Preliminary Numerical RAOs presented in the FS Work Plan, not site specific remedial action levels or a quantitative ecological risk assessment. Specific methods for refinement of remedial areas or development of action levels may be proposed in remedial design, but are beyond the scope of the FS. Any work to support refinement in RD will be subject to DEQ review and approval. DEQ has modified the FS Work Plan to be consistent with this direction.

3. DEQ's conclusion that significant attenuation of contaminant concentrations in groundwater will not occur between the riverbank wells and the transition zone exposure point must be carried forward. DEQ's April 7, 2017 General Comments-Hot Spots 1, 2; General Comment-Human Health Risk Assessment 1, and Specific Comments 4, 21, 22, 26, 27, 28, 29, 47, 51, 56, 58, 59, 60, and 80 addressed the exposure point and the potential for significant attenuation of groundwater contamination in upland wells to the in-water receptor exposure point. In LSS's November 30, 2017 response and in several sections of the *Revised FS Work Plan*, LSS's states that action levels are to be developed in the FS and the alternatives development must accommodate new data/analysis that may demonstrate attenuation of concentrations in groundwater to the transition zone. This is not consistent with DEQ's directed modifications to the *FS Work Plan*. The FS must be based on the current data set and DEQ's conclusion that significant attenuation of contaminant concentrations in groundwater will not occur between the riverbank wells and the transition zone exposure point. As DEQ stated in our August 24, 2017 meeting, DEQ is open to reviewing a remedial design work plan that presents a strategy to evaluate the potential for attenuation as part of remedy design but not as part of the FS process. The alternatives developed in the feasibility study report and the proposed remedy selected in the feasibility report must be based on DEQ's directed modification. Specific instances of statements addressing this topic in the FS Work Plan are identified below.

DEQ Modification

1. **Section 3.2.3 Upland Groundwater CDD/CDF Sampling.** LSS added text to this section to address DEQ's April 7, 2017 specific comment 31. However, the conclusion statement goes beyond DEQ's direction, and DEQ does not agree there is sufficient data and analysis to support LSS's conclusions. The data and LSS's evaluation are not robust enough to indicate that groundwater at the Site is not a source of dioxins or furans to the transition zone pore water. The following text has been modified.

...The investigation results showed limited detections, which were below many of the Portland Harbor JSCS screening values. ~~The data indicate that the groundwater at the Site does not represent a source of dioxins or furans to the transition zone pore water. Therefore, CDD/CDFs in groundwater in the former Acid Plant Area and Chlorate Manufacturing Area do not represent a significant risk to surface water or sediment and do not require remedial measures or warrant~~

~~additional evaluation. However, a~~ As directed by ODEQ, these results have been included into the Work Plan and the hot spot screening evaluation.

2. **Section 3.2.4 Site-Wide Groundwater Sampling.** The last sentence of the first paragraph states that “For the FS, LSS expects to use the most recent data or newly collected data to define groundwater hot spots.” This statement is not consistent with DEQ’s directed modification. The FS must be developed with the same data set DEQ directed LSS to use in the *FS Work Plan* and *Preliminary Hot Spot Evaluation*. See general modification 1 above. The following text has been modified.

~~... For the FS, LSS expects to use the most recent data or newly collected data to define groundwater hot spots.~~

3. **Section 3.2.4 Site-Wide Groundwater Sampling.** The first sentence states “LSS will use the 2007 and 2009 groundwater data to screen groundwater hot spots in the Work Plan, as specific by ODEQ.” This statement is not consistent with DEQ direction or earlier statements in the *Revised FS Work Plan*. Further, the Work Plan did not use all of the Rhone-Poulenc data collected in 2009. Monitoring wells on Lot’s 1 and 2 were sampled by Rhone-Poulenc in August 2009 and in January 2010. The Work Plan appears to have used the 2010 data but not the 2009 data. The following text has been modified.

LSS will use the ~~maximum of concentration from the Arkema 2006, 2007, 2008, 2009 and 2009/2010 Rhone Poulenc 2007 and 2009~~ groundwater data to screen groundwater hot spots in this Work Plan, as specified by ODEQ. ~~LSS believes that DEQ’s request is based on the premise that there will be no additional groundwater monitoring before the FS.~~ The existing data, however, are more than 8 years old and ~~are likely not may not be~~ representative of current conditions.

The hot spot evaluation must be revised using the complete data set as directed by DEQ. Summary tables presenting all the data screened needs to be included in the revised Preliminary HSE.

4. **Section 3.2.4 Site-Wide Groundwater Sampling.** The third sentence states “As agreed by the ODEQ in a 24 August 2017 meeting, LSS will propose a new round of groundwater monitoring that, if available in time, may be incorporated into the FS; otherwise, the new data will be incorporated into subsequent pre-design submittals.” DEQ did not agree to allow new data to be incorporated into the FS. The following text has been modified.

~~...As agreed by the ODEQ in a 24 August 2017 meeting, LSS will~~ ~~may~~ propose a new round of groundwater monitoring that, ~~if available in time, may be incorporated into the FS; otherwise, the new data will~~ ~~can~~ be incorporated into subsequent pre-design submittals...

5. **Section 3.2.4 Site-Wide Groundwater Sampling.** LSS incorrectly states that it cannot be known whether the northern extent of the DDx hot spots in groundwater is bounded by the hydraulic influence of the groundwater SCM. The data clearly show the DDx plume is outside of the hydraulic influence of the groundwater SMC. The following text has been modified.

~~... Accordingly, it cannot be known whether~~ the northern extent of these hot spots in groundwater ~~are outside of is bounded by~~ the hydraulic influence of the groundwater SCM...

6. **3.3.1 Revised CDD/CDF Conceptual Site Model** Due to its size and lack of clear significance to the FS Work Plan LSS's Appendix B is not included in DEQ's modified FS Work Plan. The following text has been modified.

... The report ~~is~~ was included as Appendix B of the November 2017 Draft FS Work Plan ...

7. **3.3.1 Revised CDD/CDF Conceptual Site Model** This section fails to point out that the research indicates the chlor-alkali process is a potential source of CDDs. Language modified to be consistent with the July 2013 Draft Upland Feasibility Study language. The following text has been modified.

... The Gibbs chlorine cells (used from 1946 until 1971) had the potential to form CDFs and to a much lesser extent CDDs. (Waterstone 2012). ~~It is unlikely that the cells used at the Site produced waste products with significant concentrations of CDDs (Waterstone 2012).~~

8. **Section 4.1.1 Lots 1 and 2** LSS characterization of arsenic sources at the site is incorrect. DEQ's April 7, 2017 Specific Comment 7 directed the language of this paragraph to be removed. The paragraph is not consistent with the conclusions of the approved human health risk assessment nor DEQ or EPA guidance for conducting risk assessments and must be removed from the work plan. Unacceptable levels of arsenic identified on Lots 1 & 2 must be addressed in the feasibility study. The following text has been modified.

~~The source of arsenic at the Site is not related to Site processes and therefore is naturally occurring (i.e., geogenic), has an anthropogenic background, or is from off-site sources. Furthermore, the exposure point concentration (EPC) used in the risk assessment was driven by a single extreme detected concentration.~~

9. **Section 4.1.2 Lots 3 and 4.** In DEQ's specific Comment 8 DEQ noted the potential for site operations to be a dioxin/furan source was not evaluated until after completion of the site RI and human health risk assessment. As documented in DEQ's October 23, 2008 letter, DEQ determined that catch basin solids data indicate the potential presence of dioxins and furans in sites soil above risk levels to occupational workers. Instead of requiring LSS to collect additional surface soil data DEQ agreed to move forward provided this assumption was carried into the FS. This assumption was not presented in the *FS Work Plan*. The following text has been modified to address this deficiency.

4.1.3 Dioxin Soil Lots 1, 2, 3 and 4

The potential for site operations to be a dioxin/furan source was not evaluated until after completion of the site RI and human health risk assessment. As documented in DEQ's October 23, 2008 letter, DEQ determined that catch basin solids data indicate the potential presence of dioxins and furans in sites soil above risk levels. Instead of requiring LSS to collect additional surface soil data DEQ agreed to move forward provided this assumption was carried into the FS. Dioxin/furans have been added to the COC list in surface soil for occupational workers, and the FS will present remedial alternatives to manage this potential risk.

10. **Section 4.1.2 Lots 3 and 4.** Table 4-2 presents a hot spot for "Preliminary Groundwater Hot Spot-Direct Exposure" for the "Indoor Worker" receptor. However, this pathway should be not be considered a groundwater hot spot because it is not associated with a beneficial use of groundwater. It appears this evaluation was added in response to DEQ's April 7, 2017 Specific Comment 18. DEQ's directed modification was to Section 4.3.1.1 Human Exposure Routes. This directed modification should have been to Section 4.1.2

Lots 3 and 4 [Human Health Risk Assessment]. DEQ regrets the lack of clarity in this comment. Section 4.1 Human Health Risk Assessment has been modified as follow to indicate that this data and pathway will be carried forward into the FS.

4.1.4 Groundwater

The Human Health Risk Assessment identified chloroform and 1,4-Dichlorobenzene as exceeding acceptable risk for indoor occupational workers site wide.

Additionally, the shallow monitoring well MWA-63 in which chloroform was detected at 9,800 ug/L was constructed after completion of the human health risk assessment. This chloroform concentration exceeds DEQ occupational risk-based concentration for groundwater vapor intrusion into buildings which is 1,600 ug/L. Consequently, the vapor intrusion air pathway is added to the list of human health exposure routes and will be addressed by remedial alternatives developed in the FS for this potential exposure route.

11. **Section 4.1.2 Lots 3 and 4.** The Work Plan's characterization of risk on Lots 3 and 4 is unclear in regards in what will be carried into the FS. The following text has been modified.

...These potential risks were driven by a single ~~extreme~~ concentration of tetrachloroethene (PCE) in subsurface soil and are considered an upper-bound estimate of the potential cancer risks. The total HI for the indoor worker was well less than 0.01 for both the CTE and RME case, indicating that potential ~~non-carcinogenic~~ adverse health effects are not expected. ~~The unacceptable risk associated this location will be addressed in the FS.~~

12. **Section 4.1.3 Riverbank.** The Work Plan's characterization of risk on the Riverbank in is unclear in regards in what will be carried into the FS. The following text has been modified.

These potential risks were driven by a single ~~extreme~~ concentration of PCE in subsurface soil and are considered an upper-bound estimate of the potential cancer risks. The total HI for the indoor worker was well less than 0.01 for both the CTE and RME case, indicating that potential ~~non-carcinogenic~~ adverse health effects are not expected. ~~The unacceptable risk associated this location will be addressed in the FS.~~

13. **Section 4.2.1 Receptors.** This section does not present an accurate summary of the ecological risk assessment. The following text has been modified.

...Three COCs (chromium, lead, and DDx) ~~where identified by LSS as exceeding the conservative~~ generic SLVs for at least one ecological receptor. DEQ modified the Level II screening in a March 15, 2010 letter and added alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane, DDD, DDE, DDT, TCDD TEQ, BEHP, As, Cu and Zn...

14. **4.3 Summary of Hot Spot Evaluation.** Substantial revisions to the Preliminary Hot Spot Evaluation are needed due to failure to implement DEQ's directed modifications and numerous errors in implementing the evaluation. The following text has been modified.

...~~Appendix A of this Work Plan is the revised HSE. Tables 4-2 list receptors, exposure pathways, and basis for hot spot criteria. Tables 4-3 through 4-5 list screening values and selected hot spot criteria. Appendix A includes hot spot screening tables, figures, and summary text.~~ The Preliminary Hot Spot has been separated from this Work Plan. Summary Tables 4-2 Hot Spot Receptor Pathway Evaluation; Table 4-3 Direct Exposure Pathway Based Screening Criteria; Table 4-4 Indirect Exposure Pathway Based Screening Criteria; and Table 4-5 Indirect Exposure Pathway Based Screening Criteria are to be revised and submitted as part of a revised

Preliminary Hot Spot Evaluation.

15. **Section 5.2 Impacted Media.** Additional data will not be collected prior to completion of the FS. See general comment 2 above.

... The FS will use existing RI data, Supplemental RI data, EE/CA data, Stormwater SCM and Groundwater SCM performance monitoring data, ~~and any data developed prior to completion of the FS to assess these media and potential remedial actions.~~

16. **Section 5.2 Impacted Media.** As noted in comment 9, the site has not been evaluated to determine if the elevated levels of dioxins observed in catch basins solids were associated with sawdust from power pole removal or from on-site contaminated soil. The following text has been modified.

Soil and groundwater at the Site have been impacted with VOCs, SVOCs, metals, pesticides, dioxins, and furans. ~~The Site does not appear to be a source of dioxins, and the dioxin is assumed to originate from power pole sawdust near and in the catch basins, background, and off site sources.~~

17. **Section 5.2 Impacted Media.** Changes made by LSS to this section are not consistent with DEQ's April 7, 2017 directions; are not relevant to this section; and are not consistent with DEQ's direction regarding the use of the risk assessments and preliminary hot spot conclusions. See general comment 2 and 3. DEQ has modified the text to be consistent with LSS's previous language presented in the July 2013 Draft FS Work Plan and DEQ's previous direction.

...The FS will utilize results from the approved the HHRA and Level II Screening ERA, and the areas and volumes identified in the preliminary hot spots evaluation.

~~The FS will use the ODEQ's conservative approach to develop hot spots assess the volume of contaminated media. In addition, to assess risk reduction and cost associated with levels of risk reduction (a risk range and range of approaches), the FS will evaluate areas which may require remediation based upon risk levels developed in HHRA and the Level II Screening ERA values (or alternatively Site Specific Ecological Risk Based levels) to assess the volumes of contaminated media to provide a more scientifically defensible approach based upon a range of risks versus the HSE alone. In addition, during remedial design, LSS will refine methods to assess leaching to groundwater and develop site specific remedial action levels⁴ for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre design sampling will be incorporated into the remedial design /remedial action (RD/RA).~~

18. **Section 5.2.1 Identification of Areas or Volumes of Media Which May Potentially Require Remedial Action.** The FS must identified areas and volumes that require remedial action. The section title has been changed to be consistent with the site's consent order and DEQ guidance.

5.2.1 Identification of Areas or Volumes of Media Which ~~May Potentially~~ Require Remedial Action.

19. **Section 5.2.1 Identification of Areas or Volumes of Media Which May Potentially Require Remedial Action.** LSS's modifications to this section are not consistent with DEQ's April 7, 2018 direction. The FS must be based on the numeric RAOs presented in the FS Work Plan not site specific remedial action levels. Specific methods for refinement of hot spot areas and volumes may be proposed in RD, but are beyond the

scope of the FS Work Plan. See general comment 2 and 3. The following modification to the text has been made.

~~... Some of the areas identified as preliminary hot spots (Appendix A) are based on generic screening levels. As discussed in the previous section, these preliminary hot spot areas will be further refined in the FS as site specific remedial action levels are established. The development of site specific remedial action levels is described in Section 5.3.~~

20. **Section 5.2.1 Identification of Areas or Volumes of Media Which May Potentially Require Remedial Action.** The Consent Order states in Section VI of the Scope of work the FS work plan must include “Proposed contaminant concentration levels that meet remedial goals and a preliminary estimate of the volume exceeding those concentrations, for each affected environmental media.” DEQ has modified the text to address this requirement.

~~The area and volume of impacted media that may require remedial action in the treatment approach alternative development will be calculated in the FS as the remedial actions levels are finalized. As required in the Consent Order, a preliminary estimate of volume exceeding numerical RAOs identified in this work plan will be calculated for each affected environmental medium. The results of the volume calculation for soil and groundwater will be presented in the Preliminary Hot Spot Evaluation.~~

21. **Section 5.2.2 Estimate of Preliminary Hot Spot Volumes.** Due to failure to fully implement DEQ’s April 7, 2018 directed changes and numerous errors in implementing the preliminary hot spot evaluation, the estimate of primary hot spot volumes has been removed from the FS Work Plan and will need to be revised and submitted in the Preliminary Hot Spot Evaluation. The following modification to the text has been made.

~~As required in the Consent Order, a preliminary estimate of the volume of hot spot material **was** will be calculated for applicable exposure scenarios and contaminants in soil, groundwater, and DNAPL. The results of the volume calculations for soil and groundwater will be presented in the Preliminary Hot Spot Evaluation are presented in Tables 5-2 and 5-3, respectively.~~

22. **Section 5.2.3 Refinement of Remediation Areas and Volumes.** The text in this paragraph is not clear or consistent with DEQ direction. Refinement of remediation areas and volumes may be proposed in RD but the FS areas and volumes must be based on the numerical RAOs and hot spot criteria presented in the FS Work Plan. See general comment 2 and 3 above. See general comments 2 and 3 above. The following text has been modified.

~~In addition, during remedial design, LSS will refine methods to assess leaching to groundwater and develop site specific remedial action levels⁴ for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre-design sampling will be incorporated into the remedial design /remedial action (RD/RA).~~

~~Estimates of hot spot volumes developed in the FS and used to compare alternatives will be based on conservative assumptions, as required by the ODEQ. During remedial design, LSS may propose methods to assess leaching to groundwater and develop site-specific remedial action levels for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe proposed sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre-design sampling will be incorporated into the remedial design /remedial action (RD/RA).~~

~~These areas and volumes may be refined in the remedial design based on Site-specific groundwater and leaching to groundwater and ecological action levels and contemporary datasets and site conditions. For example, passively colonized vegetation on the upland parts of Lot 1 and 2 have been altered or removed by maintenance (surface grading, gravel placement, and construction of the stormwater SCM) conducted during the implementation of the Stormwater and Groundwater SCMs, and this condition was not reflected in the Level II Screening ERA. Maintenance activities have returned Lots 1 and 2 to their industrial use conditions. Therefore, the FS will consider Lots 1 and 2 under an appropriate industrial use scenario.~~

~~LSS will work with the ODEQ to assess empirical (sampling) or theoretical (calculations, modeling, and statistics) methods to compare chemical concentrations in the transition zone to concentrations in upland groundwater by area of the Site (e.g., Lots 1, 2 vs Lots 3, 4). A statistically based sampling and analysis or a theoretical analysis may be incorporated into the remedial design to develop risk-based action levels. Alternative leaching to groundwater models, such as Summers and/or PESTAN, may be used to develop site-specific remedial action levels for both the groundwater and the leaching to groundwater pathways.~~

~~A separate technical memorandum will describe the sampling and analysis methods. The remedial design will use the data and analysis to develop upland soil and groundwater action levels and refine estimates of areas and volumes in the FS. Additional pre-design sampling may be incorporated into the RD/RA.~~

23. **5.3 Identification of Remedial Action Objectives.** Technically practicable is not a consideration during the FS process. This phase has been removed as directed in DEQ's April 7, 2017 specific comment 61. The following text has been modified.

~~...RAO 4 – Treat or remove soil hot spots to the extent technically practicable or feasible based on remedy selection balancing factors...~~

~~...RAO 6 – Treat or remove groundwater hot spots to the extent technically practicable or feasible based on remedy selection balancing factors...~~

~~...RAO 8 – Treat or remove DNAPL hot spots to the extent technically practicable or feasible based on remedy selection balancing factors...~~

24. **Section 5.3 Identification of Remedial Action Objectives.** Performance of the RAOs must be assessed against applicable numerical remedial action objectives and hot spot criteria presented in the FS Work Plan. The following text has been modified.

~~The performance of these RAOs will be assessed against applicable remedial action levels established during the FS process. Preliminary numerical RAOs (i.e., remedial action levels) are discussed below.~~

25. **Section 5.3.1 Preliminary Numerical Remedial Action Objectives.** DEQ's April 7, 2018 comment 64 indicated LSS must use the risk values from DEQ approved risk assessments or DEQ RBCs to identify numerical remedial action objectives. However, this section states that target risk ranges based on CERCLA will be used to evaluate alternatives in the FS. This is not consistent with DEQ rules or the Site's consent order. See general comment 2. The following text has been modified.

~~...In addition, for the purpose of evaluating alternatives for acceptable residual risk to human receptors, LSS intends to apply a target risk range of 1×10^{-4} to 1×10^{-6} in accordance with CERCLA and consistent with the Portland Harbor HHRA (Kennedy/Jenks Consultants 2013). The COPCs identified in the HHRA that exceeded these is target-risk range concentrations are summarized in Table 4-1. Preliminary numerical RAOs for the target range of acceptable risk to human receptors are presented in Table 5-4. During remedial design, the areas and volumes of~~

~~media requiring remediation will be refined via empirical (sampling) or theoretical (calculations, modeling, and statistics) methods to develop remedial action levels (i.e., numerical RAOs)...~~

26. Section 5.3.1 Preliminary Numerical Remedial Action Objectives, fourth paragraph.

The Preliminary Numerical RAOs presented in Table 5-5 must be used to evaluate ecological risk in the FS's residual risk evaluation consistent with the approved site ecological risk assessment. As DEQ has informed LSS a quantitative ERA may not be conducted as part of the FS. See general comment 2. The following text has been modified.

The preliminary numerical RAOs presented in Table 5-4.5 will be used for screening the residual COCs in soil to evaluate the alternatives for acceptable residual risk to ecological receptors and to evaluate residual risk. As noted above, the preliminary numerical RAOs are inherently conservative. If necessary, LSS will prepare a quantitative ERA in accordance with OAR 340-122-0084 to evaluate any residual risk to ecological populations within the locality of the facility for the proposed remedial alternatives. LSS notes that, per the Guidance for Ecological Risk Assessment: Levels I, II, III, IV (ODEQ 1998b), a Level III baseline risk assessment for the Site may need to be completed prior to the preparation of the residual risk assessment.

27. Section 5.3.1 Preliminary Numerical Remedial Action Objectives, second, third and fourth paragraph. The structure of this section makes it difficult to understand the Numerical Remedial Action Objectives for each RAO. DEQ has modified this section to clearly state what the Numerical Remedial Action Objective is and where it can be found.

RAO 1

The preliminary numerical RAOs established for direct exposure to soil for human health exposure pathways and applicable COCs, will be used to evaluate remedial alternatives to achieve RAO 1 and are summarized in Table 5-4.

The Preliminary Numerical RAOs are the risk values from either the ODEQ approved upland HHRA or the ODEQ RBDM Table 11. Areas and volumes in the FS will be based on these Preliminary Numeric RAOs. The COPCs identified in the HHRA that exceeded these risk concentrations are summarized in Table 4-1.

RAO 2

The preliminary numerical RAOs established for direct exposure to soil for ecological exposure pathways and contaminants of interest are the Screening Benchmark Values used in the ecological risk assessment and are summarized in Table 5-5.

The preliminary numerical RAOs presented in Table 5-4.5 will be used for screening the residual COCs in soil to evaluate the alternatives for acceptable residual risk to ecological receptors and to evaluate residual risk.

28. Section 5.3.1 Preliminary Numerical Remedial Action Objectives. Numerical Remedial Action Objectives are not presented for RAO 3. DEQ has modified the text to address this deficiency.

RAO 3

The numerical RAOs for established for soil erosion to Willamette River are the Portland Harbor RAO 9 Cleanup Levels, or if not available the Joint Source Control SLVs used in the December 2008 Riverbank Erodible Soil Source Control Evaluation. Table 5-7 presents the Preliminary Numerical RAOs for contaminants identified as exceeding JSCS SLVs in the Riverbank Erodible Soil Source Control Evaluation. The Preliminary Numerical RAOs presented in Table 5-7 will be used to evaluate remedial alternatives to achieve RAO 3.

29. **Section 5.3.1 Preliminary Numerical Remedial Action Objectives.** Numerical Remedial Action Objectives are not presented for RAO 4 in this section. DEQ has modified the text to address this deficiency.

RAO 4

The Preliminary Numerical RAOs for hot spots established for direct exposure to soil for human health exposure and ecological receptor pathways are summarized in Table 5-4 and 5-5. The hot spot criteria presented in Table 5-4 are based on the risk values from either the ODEQ approved upland HHRA or the ODEQ RBDM Table 11. The hot spot criteria presented in Table 5-5 are based on ODEQ Ecological Risk Screening Benchmark Values. These hot spot criteria will be used in the Preliminary Hot Spot Evaluation and in the FS to evaluate remedial alternatives to achieve RAO 4.

30. **Section 5.3.1 Preliminary Numerical Remedial Action Objectives.** The Preliminary Numerical RAOs developed in this FS Work Plan must be used in the FS. See general comment 3. The following text has been modified.

~~*The preliminary numerical RAOs established for indirect exposure to groundwater and soil for ecological exposure pathways and applicable COCs are presented in Table 5-6.*~~

~~*As discussed previously in Sections 4.3.2 and 4.3.3, LSS intends to develop Site specific remedial action levels for groundwater and soil leaching to groundwater pathways. These remedial action levels will be used to evaluate the performance of remedial actions at achieving the RAOs.*~~

RAO 5

The Preliminary Numeric RAOs established for groundwater migration to the Willamette River are protective of the DEQ identified beneficial use of groundwater; recharge to aquatic habitat, as well as EPA's Portland Harbor determined use for surface water as a drinking water source. Groundwater Preliminary Numeric RAOs are based on the lowest applicable Ambient Water Quality Criteria (AWQC). If aquatic life AWQC are not available the lower of the DEQ Table 33C (currently Table 31) or ORNL values are used. Preliminary Numeric RAOs for groundwater are presented in Table 5-6.

Note that the Preliminary Numeric RAOs for RAO 5 are different from the groundwater Hot Spot Criteria in that they are based on the AWQC for "human health for the consumption of water and Organism". This difference results from EPA's source control decision which determined the Willamette River is a potential drinking water source. DEQ Cleanup Program does not consider the Willamette River a potential drinking water source so this pathway was not carried into the Preliminary Hot Spot Evaluation.

31. **Section 5.3.1 Preliminary Numerical Remedial Action Objectives.** Preliminary Numerical RAOs were not presented for RAO 6 in this section. DEQ has modified the text to address this deficiency.

RAO 6

The Preliminary Numeric RAOs established for groundwater discharging to the Willamette River hot spots are protective of the DEQ identified beneficial use of groundwater. Groundwater Preliminary Numeric RAOs are based on the lowest applicable Ambient Water Quality Criteria (AWQC). If aquatic life AWQC are not available the lower of the DEQ Table 33C (currently Table 31) or ORNL values are used. Soil Preliminary Numeric RAOs are based on the groundwater values and an equilibration calculation with a generic dilution and attenuation factor. Preliminary Numeric RAOs for groundwater are the hot spot criteria presented in Table 4-4. Preliminary Numeric RAOs for soil will be presented in the Preliminary Hot Spot Evaluation.

Note that the Preliminary Numeric RAOs for RAO 6 are Hot Spot Criteria and are different then

*the Preliminary Numeric RAOs for RAO5, in that they are based on the AWQC for “**human health for the consumption of Organism Only**”. This difference results from EPA’s source control decision, which determined the Willamette River is a potential drinking water source. DEQ Cleanup Program does not consider the Willamette River a potential drinking water source so this pathway was not carried into the Preliminary Hot Spot Evaluation.*

32. **Section 5.3.1 Preliminary Numerical Remedial Action Objectives.** Preliminary Numerical RAOs were not clearly addressed for RAO 7 and 8. DEQ has modified the text to address this.

RAO 7 and 8

Preliminary numerical RAOs are not applicable to RAO 7 and 8.

33. **Section 5.3 Identification of Remedial Action Objectives.** LSS did not address DEQ’s April 7, 2017 Comment 62 or 65, which directed the FS Work Plan identify numeric values for RAO 9 and 10. See general comment 2. The following text has been modified.

~~There are currently no Site specific numerical RAOs for the Stormwater SCM. Stormwater treatment alternatives will be developed to meet the effluent goals and the stormwater RAOs to the extent technically possible in considering the balancing factors of the FS.~~

RAO9 and 10

The Preliminary Numerical RAOs established for stormwater discharge to the Willamette River are the Portland Harbor RAO 9 Cleanup Levels for surface water. Table 5-8 presents the Preliminary Numerical RAOs for contaminants identified in Attachment A of the Stormwater Source Control Measure Mutual Agreement and Order (No. WQ/1-NWR-10-175). The Preliminary Numerical RAOs presented in Table 5-8 will be used to evaluate remedial alternatives to achieve RAO 9 and 10.

34. **Section 5.4 Identification of General Response Actions, second paragraph.** The FS must be based on the current data set. See general comment 1. The following text has been modified.

...The FS will use existing data and historical Site information to identify Site conditions that may limit or promote specific response actions ~~and any new data gathered as part of or in advance of completing the FS...~~

35. **Section 5.4 Identification of General Response Actions, third paragraph.** DEQ added text to clarify it is DEQ’s role, not LSS’s to determine if a general response action should be eliminated. The following text has been modified.

Oregon environmental cleanup law allows the elimination of one or more general response actions from development if the ~~Department determines the~~ proposed remedial action alternative(s) is not clearly protective, feasible, or otherwise appropriate for the facility, as specified in OAR 340-122-0085 (3).

36. **Section 5.6 Evaluation of Remedial Action Alternatives, first paragraph.** DEQ notes that the assembled alternatives must included the stated objectives. The following text has been modified.

... The assembled alternatives ~~may~~ will include additional technology considerations to remove or treat hot spots soils, enhance DNAPL treatment or removal, and impacted groundwater cleanup necessary to meet the Site-specific RAOs.

37. **Section 5.6 Evaluation of Remedial Action Alternatives, second paragraph.** The range of technologies needs to include hydraulic isolation, and in-river capping consistent with DEQ's expectations. The following text has been modified.

*Groundwater – hydraulic containment and ex situ treatment (currently being implemented), in situ treatment, in situ stabilization/fixation, **hydraulic isolation, in-river capping** and monitored natural attenuation.*

38. **Section 6.0 Evaluation of Remedial Action Alternatives.** The numeric RAOs identified in the FS Work Plan must be used in the FS. See general comment 2. The following text has been modified.

*The **preliminary numerical** RAOs ~~developed during the FS~~ identified in the FS Work Plan are used as quantitative indicators of protectiveness and hot spot treatment levels.*

39. **Section 6.4.2 Comparative Analysis of Alternatives.** DEQ deleted this paragraph and moved it to Section 6.4.3 to be consistent with the hot spot rule. The following text has been modified.

~~Subject to the preference for treatment of hot spots, the least expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors. The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management.~~

40. **Section 6.4.3 Recommended Remedial Action Alternative.** DEQ revised this paragraph to be consistent with the hot spot rule. The following text has been modified.

~~...In general, the recommended alternative should be the least expensive protective alternative, unless the additional cost for a more expensive alternative is justified by proportionately greater benefits within one of the remedy selection factors and significant decrease in residual risk.~~
Subject to the preference for treatment of hot spots, the least expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors. The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management.

41. **Table 4-1.** The term COPC [contaminant of potential concern] is used incorrectly. The human health risk assessment and ecological risk assessments have been completed for the site and therefore these contaminants are considered Contaminants of Concern (COC). The table has been modified to address this error.

1) ~~COPCs~~ **COC** with Non-Cancer Risk

2) ~~COPCs~~ **COC** with Carcinogenic Risk

42. **Table 4-1.** DEQ's specific Comment 9 noted the potential for site operations to be a dioxin/furan source was not evaluated until after completion of the site RI and human health risk assessment. As documented in DEQ's October 23, 2008 letter, DEQ determined that catch basin solids data indicate the potential presence of dioxins and furans in sites soil above risk levels to occupational workers. Instead of requiring LSS to collect additional surface soil data DEQ agreed to move forward provided this assumption was carried into the FS. TCDD TEQ has been added to the list of COCs for

Lots 1&2 and Lots 3&4. Table 4-1 has been modified in the Preliminary Hot Spot evaluation to reflect this.

1) Lots 1&2 – *TCDD TEQ*

2) Lots 3&4 – *TCDD TEQ*

43. **Table 4-1.** Table presents human health COCs for carcinogenic risk $>1\text{E-}04$ and $>1\text{E-}05$. These risk ranges are not relevant in determining site COC and have been deleted from the table.

1) *Carcinogenic Risk $>1\text{E-}04$*

2) *Carcinogenic Risk $>1\text{E-}05$*

44. **Table 4-1.** 1,4-Dichlorobenzene was not identified as exceeding $1\text{E-}6$ excess cancer risk for Indoor Workers Lots 3&4 as shown on Table 6-15 of the *Human Health Risk Assessment Arkema Site: Upland Areas*. This COC has been added to the table.

Indoor Worker – 1,4-Dichlorobenzene, PCE

45. **Table 4-1.** TCDD TEQ was not identified as exceeding $1\text{E-}6$ excess cancer risk for Construction Workers Riverbank as shown on Table 6-25 of the *Human Health Risk Assessment Arkema Site: Upland Areas*. This COC has been added to the table.

Construction Worker – As, TCDD TEQ

46. **Table 4-1.** Table 4-1 does not present an accurate list of COCs for ecological receptors. Table 4-1 has been revised to show ecological COCs based on the January 16, 2009 Arkema Upland Level II Screening Ecological Risk Assessment and DEQ's March 15, 2010 modifications to the Ecological Risk Assessment. For clarity DEQ has also added a column to the table specifically for ecological COCs. The following ecological COCs have been added to the table:

Plants – beta HCH, As, Cu, Zn

Bird – DDD, DDE, DDT, TCDD TEQ, PCBs, As, Cu, Zn

Mammal – DDD, DDE, DDT, PCBs, TCDD TEQ, alpha-HCH, BEHP, As, Cu, Zn.

47. **Table 4-2.** DEQ's April 7, 2017 Specific Comment #81 directed LSS to list out all individual contaminants for each hot spot. LSS did not address this DEQ identified deficiency. Additionally there appears to be a number of errors associated with the COCs that were identified this table. Such as:

- For the Preliminary Groundwater Hot Spot-Indirect Exposure compounds Table 4-2 does not list the COCs associated with this pathway. Instead Table 4-4 is referenced as presenting the list of hot spot compounds for this pathway.

Further, Table 4-4 does not present this information. Table 4-4 lists the COCs identified in the Human Health Risk Assessment. Not all of these compounds are listed are associated with hot spots for this pathway.

- Table 4-2 identifies arsenic as a hot spot compound for the outdoor worker on Lots 1 and 2. A review of Table A-4 does not indicate arsenic concentrations above the hot spot criteria for this pathway.
- Table 4-2 does not identify 2,3,7,8-TCDD TEQ as a hot spot compound for the outdoor worker. A review of Table A-4 indicates that 2,3,7,8-TCDD TEQ exceeds the hot spot criteria for this pathway.
- Table 4-2 does not identify DDE as a hot spot compound for the outdoor worker a review of Table A-4 indicates that DDE exceeds the hot spot criteria for this pathway.
- Table 4-2 does not present the full list of ecological COCs. See specific comment 13.

DEQ has modified the table and eliminated the “Compounds” column to address this error for the Work Plan. However, a revised Table 4-2 listing out all individual compounds for each hot spot must be included in the revised Preliminary Hot Spot Evaluation that incorporates all of DEQ’s modifications and the revised Hot Spot Evaluation conclusions.

48. **Table 4-2.** The rationale for identifying Screening Criteria for groundwater discharge to Willamette River is not consistent with DEQ direction. The following text has been modified.

Per DEQ comments, lowest of applicable screening criteria from DEQ Table 30, EPA NRWQC, and DEQ Table 40 were selected. Where chronic AWQC are not available, the lowest DEQ Table 31, or ORNL, or DEQ provided values were used.

49. **Table 4-3.** An updated table presenting RBCs, SLVs and highly concentrated hot spot screening levels is needed based on DEQ’s modifications to the FS Work Plan and review comments on the preliminary hot spot evaluation. While additional modifications may be needed based on DEQ’s current modifications of the FS Work Plan and future comments on the preliminary hot spot evaluation, DEQ modified the table to address the following issues.

- All ecological COCs identified in the Level II Ecological Screening Risk Assessment and DEQ’s March 15, 2010 modification are presented. See tables 46 above.
- SLVs and hot spot criteria are needed for all human health and ecological COCs
- Incorrect RBCs and Hot Spot Criteria were corrected as shown
- Explanation of when and how TCDD TEQ hot spot criteria ecological receptors will be developed.

Table 4-3 must be revised to correct errors and submitted with the revised preliminary hot spot evaluation. DEQ notes that additional contaminants may need to be added to Table 4-3 to be consistent with DEQ’s comments and the revised Preliminary Hot Spot Evaluation. See comment 14 above.

50. **Table 4-4.** This table needs to present Hot Spot Criteria for groundwater discharge to the Willamette River which are the Preliminary Numerical RAOs for RAO 6. DEQ has modified the title. DEQ has modified this table for the Work Plan. However, a revised Table 4-4 must be presented in the Preliminary Hot Spot Evaluation. The table must be revised to correct errors and address DEQ's directed modification.

51. **Table 4-4.** It is not clear how the list of COCs presented in this table was developed or if it is appropriate for assessing the discharge of groundwater to the Willamette River. This table must be revised to present Hot Spot Criteria for all compounds detected in groundwater. A revised Table 4-4 must be presented in the Preliminary Hot Spot Evaluation and revised to correct errors and address DEQ's directed modification.

52. **Table 4-4.** This table does not appear to be consistent with the evaluation presented in Tables A-11.

- Table 4-4 presents chlordane as a compound while Tables A-11 present Total chlordanes without a definition. The report needs to evaluate chlordane and Total chlordanes separately and constantly.
- Table 4-4 presents dichlorobenzenes as a humane health COC but total dichlorobenzenes is not defined or evaluated.
- Table 4-4 presents 1,2-dichloroethene, 1,3-dichloropropene, chlorodibromomethane, as human health COCs but they are not screened on Table A-11 or evaluated.

A revised Table 4-4 must be presented in the Preliminary Hot Spot Evaluation. The table must be revised to correct errors and address DEQ's directed modification.

53. **Table 4-4.** DEQ's April 7, 2017 Specific Comment #24 directed LSS to use the Oak Ridge National Laboratory (ORNL) value for contaminants that do not have Aquatic Life water Quality Criteria (AWQC) chronic values. LSS did not address this DEQ identified deficiency. The hot spot criteria for several contaminants is incorrectly identified in Table 4-4 and in the subsequent evaluation. A revised evaluation is needed for the following contaminants.

Contaminant of Concern	LSS Identified Hot Spot Criteria (µg/L)		Correct Hot Spot Criteria (µg/L)	
1,1,1-Trichloroethane	200,000	EPA NRWQC (HH)	11	Oak Ridge National Lab
1,2-Dichlorobenzene	130	EPA NRWQC (HH)	14	Oak Ridge National Lab
1,4-Dichlorobenzene	19	HHWQC Table 40	15	Oak Ridge National Lab
Chlorobenzene	160	HHWQC Table 40	64	Oak Ridge National Lab
Chloroform	1,100	HHWQC Table 40	28	Oak Ridge National Lab

Ethylbenzene	130	EPA NRWQC (HH)	7.3	Oak Ridge National Lab
Toluene	520	EPA NRWQC (HH)	9.8	Oak Ridge National Lab
Anthracene	400	EPA NRWQC (HH)	0.73	Oak Ridge National Lab
Fluorene	70	EPA NRWQC (HH)	3.9	Oak Ridge National Lab

DEQ has modified this table for the Work Plan. However, a revised Table 4-4 must be presented in the Preliminary Hot Spot Evaluation. The table must be revised to correct errors and address DEQ's directed modification.

54. **Table 4-4.** DEQ's April 7, 2017 Specific Comment #39 directed LSS to use the Oak Ridge National Laboratory (ORNL) value of 28 µg/L as the Hot Spot Criteria for chloroform. LSS did not address this DEQ identified deficiency.
55. **Table 4-4.** DEQ's April 7, 2017 Specific Comment #42 directed LSS to use the Oak Ridge National Laboratory (ORNL) value of 14 µg/L as the Hot Spot Criteria for 1,2-dichlorobenzene. LSS did not address this DEQ identified deficiency.
56. **Table 4-5.** Incorrect groundwater hot spot criteria, as discussed in comments above, were used to derive the leaching to groundwater soil hot spot criteria. Additionally, the DAF was modified from 20x to 60x without explanation or approval from DEQ. The table must be revised to correct errors and address DEQ's directed modification. A revised Table 4-5 must be presented in the Preliminary Hot Spot Evaluation. DEQ has deleted Table 4-5 from the FS Work Plan.
57. **Table 5-2 Estimated Hot Spot Volumes in Soil.** Per comment 21 above this table has been deleted from FS Work Plan and will need to be revised and included in the Preliminary Hot Spot Evaluation. DEQ notes volume estimates for several COCs with concentrations that exceed hot spot criteria as shown in Tables A-1 through A-6 are not presented in Table 5-2, for example:
 - 1,4-Dichlorobenene in Soil – Indoor Worker
 - 4,4'-DDE in soil – Outdoor Worker
 - 4,4'-DDE in soil – Construction Worker
 - 4,4'-DDT in soil – Excavation Worker
 - 2,3,7,8-TCDD TEQ in Soil – Outdoor Worker Receptor
 - Total Chromium in Soil – Terrestrial Ecological Receptor
 - Lead in soil - Terrestrial Ecological Receptor
 - 4,4'-DDT in soil - Terrestrial Ecological Receptor
 - 4,4'-DDD in soil - Terrestrial Ecological Receptor

- 4,4'-DDE in soil - Terrestrial Ecological Receptor

Area and volume estimates for all COCs that exceed hot spot criteria will need to be presented in the Preliminary Hot Spot Evaluation.

In addition to addressing all hot spot contaminants the table will need to be revised to address the following:

- DEQ notes the areas and volumes presented in Table 5-2 appear to be much larger than the areas presented on the associated figures. An explanation needs to be presented on how these estimates were calculated. It is unclear if the areas and volumes presented are for areas that exceed risk levels and the table is titled incorrectly or if there was an error in the calculations.
- DEQ notes "Ecological" is listed for the "receptor" for all leaching to groundwater hot spots. However, the leaching to groundwater hot spot criteria was based on the lowest human health or ecological screening level criteria. For all but zinc the hot spot criteria is based on the human health screening level value. This table will need to be modified to indicate that the "receptor" is ecological/human health.
- DEQ notes the estimated volume of DNAPL has been eliminated in the revised table. An estimate of the area and volume of the DNAPL hot spot will need to be presented in the revised table.

58. **Table 5-3 Estimated Hot Spot Volumes in Groundwater.** Per comment 21 above this table has been deleted from FS Work Plan and will need to be revised and included in the Preliminary Hot Spot Evaluation.

- DEQ notes volumes for several contaminants that exceeded hot spot criteria in groundwater as shown in Table A-11 were not presented in Table 5-3, such as: copper, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, Carbon disulfide, Carbon tetrachloride, Hexachlorobutadiene, methylene chloride, bromodichloromethane, dibromochloromethane, alpha-BHC, beta-BHC, 4,4'-DDD, and 4,4'-DDE. An explanation of which hot spot volumes were calculated is needed as part of the Preliminary Hot Spot Evaluation.
- DEQ notes it is unclear what the "Depth Interval Volume" column presents. An explanation of what this column presents will be needed in the revised table.
- An explanation needs to be presented on how these estimates were calculated.

59. **Table 5-4.** The preliminary numerical RAOs must be the RBCs based on 1×10^{-6} carcinogenic risk range consistent with Oregon law. The columns presenting the 1×10^{-5} and 1×10^{-4} carcinogenic Risk Range have been deleted as they are not relevant for development of the Preliminary Numerical RAOs.

60. **Table 5-4.** Table needs to clearly identify the DEQ directed preliminary numerical RAO for Human Health Receptors. The column titled "RBDM SLVs" has been changed to "Preliminary Numerical RAOs".

61. **Table 5-4.** Preliminary Numerical Remedial Action Objectives for all COCs must be the current RBDM SLVs based on the May 2018 update. The table has been updated with the current RBDM SLVs and Hot Spot Criteria.
62. **Table 5-5.** Table needs to clearly identify the DEQ directed Preliminary Numerical RAO for Ecological Receptors. The column titled “Screening Benchmark Levels” has been changed to “Preliminary Numerical RAOs”.
63. **Table 5-5.** Table 5-5 does not present an accurate list of COCs for ecological receptors. Table 5-5 has been revised to show ecological COCs based on the January 16, 2009 Arkema Upland Level II Screening Ecological Risk Assessment and DEQ’s March 15, 2010 modifications to the Ecological Risk Assessment. Preliminary Numeric RAOs for following ecological COCs have been added to the table:

Plants - beta HCH, As, Cu, Zn

Bird – TCDD TEQ, PCBs, As, Cu, Zn

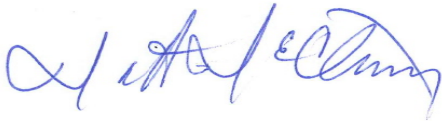
Mammal – PCBs, TCDD TEQ, alpha-HCH, BEHP, As, Cu, Zn.

64. **Table 5-5.** The numerical RAO for 2,3,7,8-TCDD TEQ was presented as TBD. The 2,3,7,8-TCDD TEQ for birds is 5.5E-5 mg/kg and for mammals is 1.2E-4 mg/kg. A value for inverts is not presented in DEQ Guidance. Table 5-5 has been updated to address this error.
65. **Table 5-6.** Table 5-6 was modified incorrectly and no longer identifies the preliminary numerical RAO’s established for indirect exposure to groundwater and soil for ecological exposure pathways and applicable COCs. Instead it identifies the “Selected Hot Spot Criterion” and “Leaching to Groundwater Criteria” based on human health and ecological receptors. This table must be revised to identify the DEQ directed preliminary numerical RAOs for indirect exposure pathways for ecological receptors.
66. **Table 5-6.** Table 5-6 used values for “human health for the consumption of organism only” instead of “human health for the consumption of water and organism”. Additionally, the Oak Ridge National Laboratory values were not used as directed. The Preliminary Numeric RAOs established for groundwater migration to the Willamette River need to be protective of the DEQ identified beneficial use of groundwater; recharge to aquatic habitat, as well as EPA’s Portland Harbor determined use for surface water as a drinking water source. Groundwater Preliminary Numeric RAOs are based on the lowest applicable Ambient Water Quality Criteria (AWQC). If aquatic life AWQC are not available the lower of the DEQ Table 33C (currently Table 31) or ORNL values are used. Note that the Preliminary Numeric RAOs for RAO 5 are different from the groundwater Hot Spot Criteria in that they are based on the AWQC for “**human health for the consumption of water and Organism**”. This difference results from EPA’s source control decision which determined the Willamette River is a potential drinking water source. DEQ does not consider the Willamette River a potential drinking water source so this pathway was not carried into the Preliminary Hot Spot Evaluation. DEQ has modified the table to correct these errors but a revised Table 5-6 will need to be presented in the Preliminary Hot Spot Evaluation and revised to correct errors and address DEQ’s directed modification.

67. **Table 5-6.** It is not clear how the list of COCs presented in this table was developed or if it is appropriate for assessing the discharge of groundwater to the Willamette River. Foot note "C" states the list of COCs is based on the Human Health Risk Assessment, however Preliminary Numerical RAOs for discharge to the Willamette River are based on exceedances of the beneficial use criteria, not the human health risk assessment. Numeric RAOs must be developed for all contaminants detected in groundwater with a complete pathway to the river. A revised Table 5-6 must be presented in the Preliminary Hot Spot Evaluation and revised to correct errors and address DEQ's directed modification.

The FS Work Plan is approved as modified in this letter. The next steps in the Feasibly Study process is for DEQ to issues comments on the Preliminary Hot Spot Evaluation, submittal of Preliminary Hot Spot revisions and development of the alternatives. Please feel free to contact me at 503 229-5538 if you have any questions.

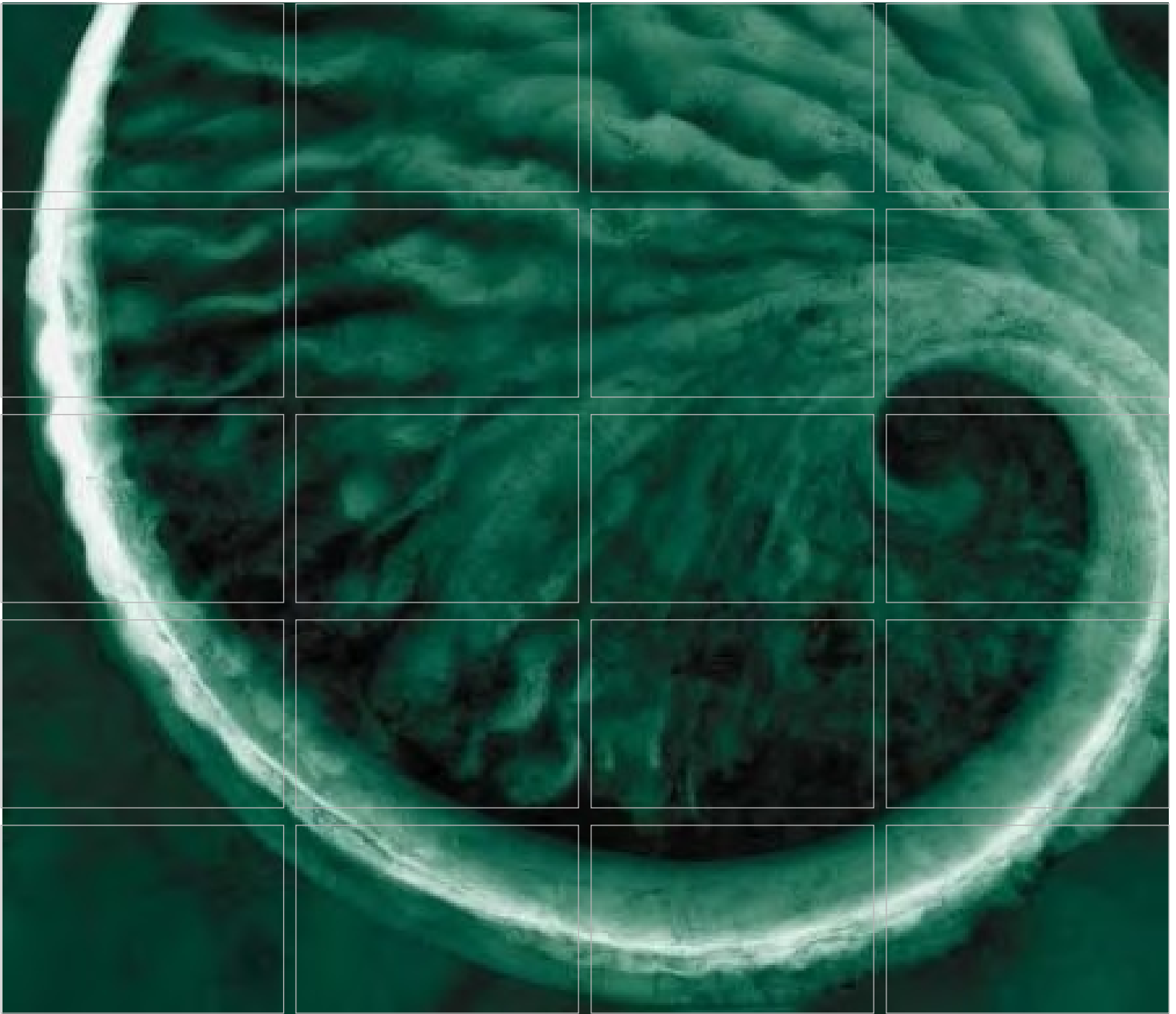
Sincerely,



Matt McClincy, Project Manager
DEQ NWR Cleanup Program

Attachment 1

Redline Version of DEQ Modified –Revised Upland Feasibility Study Work Plan



Revised Upland Feasibility Study Work Plan

Prepared for:
Legacy Site Services LLC

**Modified by DEQ
January 2019**

Arkema Facility
Portland, Oregon

November 2017

www.erm.com



Legacy Site Services LLC

Revised Upland Feasibility Study
Work Plan
Arkema Facility
Portland, Oregon

December 2017

Project No. 0164096



Brendan Robinson, P.E.

Project Engineer



David Edwards.

Partner

Environmental Resources Management
1001 SW 5th Avenue, Suite 1010
Portland, Oregon 97204
T: 503-488-5282

F: 503-488-5142

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~~**APPENDIX A — REVISED HOT SPOT EVALUATION WITH TABLES AND FIGURES**~~
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~~**AT THE FORMER ARKEMA CHLORATE/CHLORINE MANUFACTURING-**~~
~~**FACILITY**~~

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LIST OF ABBREVIATIONS

AMEC	AMEC Earth & Environmental, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
AS	air sparging
AWQC	Ambient Water Quality Criteria
bgs	below the ground surface
BMP	best management practice
BPA	Bonneville Power Administration
CaSx	calcium polysulfide
CDD	chlorinated dioxins
CDF	chlorinated furans
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
Cr[VI]	hexavalent chromium
CSM	conceptual site model
CTE	central tendency exposure
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDx	sum total of DDD, DDE, and DDT
DNAPL	dense non-aqueous-phase liquid
EE/CA	engineering evaluation and cost analysis
ERA	ecological risk assessment
ERM	ERM-West, Inc.
EPC	exposure point concentration
FFS	focused feasibility study
FS	feasibility study
GLISP	Guild's Lake Industrial Sanctuary Plan
GWET	groundwater extraction and treatment
HHRA	human health risk assessment
HI	hazard index
HSE	hot spot evaluation
IRM	interim remedial measure
JSCS	Joint Source Control Strategy
LOF	locality of facility
LSS	Legacy Site Services LLC (agent for Arkema Inc.)
MAO	Memorandum of Agreement and Order
MCB	monochlorobenzene
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter

MPR	manufacturing process residue
NAVD88	North American Vertical Datum of 1988
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
OCTF	Old Caustic Tank Farm
OCS	octachlorostyrene
ODEQ	Oregon Department of Environmental Quality
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
PCE	tetrachloroethene
PCNs	polychlorinated naphthalenes
RAA	remedial action area
RAE	riverbank alternatives evaluation
RAO	remedial action objective
RBDM	Risk-Based Decision Making
RD/RA	remedial design / remedial action
RI	remedial investigation
RME	reasonable maximum exposure
SCM	source control measure
SCSE	source control screening evaluation
SLV	screening level value
SLLI	StarLink Logistics Inc.
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TEQ	toxicity equivalence quotient
TCDD	tetrachlorodibenzo-p-dioxin
TPH	total petroleum hydrocarbon
TPH-d	total petroleum hydrocarbon-diesel
TPH-g	total petroleum hydrocarbon-gasoline
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 INTRODUCTION

On behalf of Legacy Site Services LLC (LSS), agent for Arkema Inc. (Arkema), ERM-West, Inc. (ERM) prepared this Revised Upland Feasibility Study (FS) Work Plan (Work Plan) for the former Arkema facility in Portland, Oregon (the “Site”). This revision of the Work Plan addresses Oregon Department of Environmental Quality (ODEQ) comments on the July 2013 draft Work Plan received by letter on 7 April 2017 (ODEQ 2017) and discussed at a meeting with the ODEQ on 24 August 2017.

The Work Plan was prepared pursuant to the Order on Consent requiring source control measures (SCMs) and an upland FS; the Order on Consent was issued by the ODEQ and signed 31 October 2008 (ODEQ No. LQVC-NWR-08-04) (Consent Order). This Work Plan presents the objectives and approach to perform the upland FS at the Site in accordance with the Consent Order and follows the ODEQ *Final Guidance for Conducting Feasibility Studies* (ODEQ 2006).

1.1 WORK PLAN OBJECTIVES

The primary objectives of this Work Plan are to:

- Summarize the conclusions of the remedial investigation (RI), Supplemental RI, conceptual site model (CSM), and risk assessments;
- Summarize the completed remedial actions, interim remedial actions, and ongoing SCMs;
- Develop preliminary remedial action objectives (RAOs) for affected media and relevant hot spots; and
- Describe how remedial action alternatives will be developed, screened, and evaluated in the upland FS.

1.2 WORK PLAN ORGANIZATION

The remainder of this Work Plan is organized as follows:

- Section 2.0 – Site Background
- Section 3.0 – Summary of Previous Investigations and Source Control Measures
- Section 4.0 – Summary of Risk Assessments and Hot Spot Evaluations
- Section 5.0 – Development of Remedial Action Alternatives
- Section 6.0 – Evaluation of Remedial Action Alternatives
- Section 7.0 – Reporting

- Section 8.0 – References

2.0 SITE BACKGROUND

The Site is located at 6400 NW Front Avenue in the northwest industrial area of Portland, Oregon. The Site is located in the heart of the Guild's Lake Industrial Sanctuary, which is zoned and designated by the City of Portland as "IH" for heavy industrial use. The Site is bounded by Front Avenue on the north and west, the Willamette River on the east, and an asphalt roofing manufacturer on the south. The facility manufactured chemicals for over 50 years. Manufacturing ceased in 2001, and the plant was decommissioned and dismantled in 2004. For reference, a Site location map and layout are included as Figures 2-1 and 2-2, respectively. Figure 2-2 also shows the locations of historical operations. The Site is divided into Lots 1 through 4.

2.1 HISTORICAL SITE OPERATIONS

Starting in 1941, various chemicals were produced at the facility: sodium chlorate, potassium chlorate, chlorine, sodium hydroxide, dichlorodiphenyltrichloroethane (DDT), sodium orthosilicate, magnesium chloride hexahydrate, ammonia, ammonium perchlorate, sodium perchlorate, and hydrochloric acid. Most recently, the facility was a chlor-alkali plant until the plant shut down in 2001. The RI Report (ERM 2005) described historical Site operation and manufacturing processes.

2.2 CURRENT SITE OPERATIONS

Currently, most of the Site is paved, gravel-covered/capped, or covered with building foundations. The only remaining historical building on Site is the former administration building, located near the Site entrance in the southwest corner of the Site. The groundwater extraction and treatment (GWET) system building is located in the central area of the Site, primarily on Lot 3 near the Willamette River. The only current activities at the Site are general maintenance and those associated with the interim SCMs.

2.3 CURRENT AND FUTURE LAND USE

This section describes the current and reasonably anticipated future land use in the locality of facility (LOF) in accordance with Oregon Administrative Rule (OAR) 340-122-0080(3)(e) and *Consideration of Land Use in Environmental Remedial Actions* (ODEQ 1998c). According to this guidance, the following must be taken into account when selecting a remedial action:

- Current land uses;
- Zoning, comprehensive plan, or other land use designations;

- Land use regulations from any governmental body having jurisdiction;
- Concerns of the facility owner, the neighboring owners, and the community; and
- Other relevant factors.

The current and reasonably anticipated future land use in the LOF is defined by the Site's location. The Site is located in the heart of the Guild's Lake Industrial Sanctuary, which is zoned and designated by the City of Portland as "IH" for heavy industrial use. On 14 December 2001, the Portland City Council voted to adopt the Guild's Lake Industrial Sanctuary Plan (GLISP) (City of Portland 2001). The GLISP is intended to preserve industrial land in the area generally bounded by Vaughn Street on the south, the St. Johns Bridge on the north, Highway 30 on the west, and the Willamette River on the east. The plan became effective on 21 December 2001.

The purpose of the GLISP is to maintain and protect this area as a dedicated place for heavy and general industrial uses. The plan's vision statement, policies, and objectives were adopted as part of Portland's Comprehensive Plan and are implemented through amendments to the City's Zoning Code. As a result of the GLISP, future land use in the LOF must be industrial.

2.4 GEOLOGY

The surficial geology in the Site area is characterized by fill and alluvial deposits of the Willamette River. Alluvial deposits are underlain by bedrock of the Columbia River Basalt Group. Geologic units are described in detail in the following sections.

2.4.1 *Fill Materials*

Fill generally occurs from the surface to depths of approximately 20 to 30 feet below the ground surface (bgs), and consists of clayey silt to silty sand with occasional debris (including wood, brick, concrete, gravel, demolition debris, etc.). Historically, fill materials were used to extend the Site land surface. Fill thickness ranges from a few feet in the former manufacturing area to approximately 25 feet bgs along the riverbank. The sources of the fill are primarily river dredge spoils and deposits from the City of Portland and other off-site and on-site excavations (ERM 2005). Filling with materials from excavations and dredging was common practice for near-shore areas of properties along the Portland Harbor. The shallow, fine-grained soils are the result of dredged material from the Willamette River being placed on the upland portions of the Site. In some areas of the Site, fill placement has resulted in an extension of the ground

surface into the river by a distance of as much as 300 feet.

Areas to the west of the Site, including the former Doane Lake area, have historically been in-filled with sand, clay, organic material, and miscellaneous debris. An engineered landfill and cap were also constructed over a large portion of the Gould site, located across NW Front Avenue to the west of the Site.

2.4.2 Alluvial Deposits

The alluvial deposits are typically sand, silty sands, silts, and clays. These sands and silts are massive to finely laminated, and the contacts between the sand and silt can be gradational.

In general, the alluvium occurs in four alternating sand and silt layers; a sand layer occurs at the ground surface Shallow Zone, underlain by a silt layer (Shallow-Intermediate Silt), which is underlain by an additional sand (Intermediate Zone) and a silty sand/sandy silt layer (Deep Zone). The sand and silt layers are continuous over most of the Site. The depth of the alluvium (between 50 and 205 feet bgs) is generally controlled by the topography of the underlying basalt bedrock.

A layer of gravel underlies the deepest sandy silt layer in a limited portion of Lot 1 (Figure 2-2). The gravel consists of subrounded to round colluvial and alluvial gravel. The gravel is approximately 10 feet thick.

2.4.3 Bedrock

The Columbia River Basalt Group, which consists of flood basalt that erupted 6 to 17 million years ago, underlies the fill and alluvium throughout the area. These Miocene-age flood basalts are characterized by a thick sequence of dense basalt flows separated by permeable interflow zones. These interflow zones are recognized as productive aquifers. Regionally, the basalt surface dips steeply to the northeast; however, a trough or basin has been identified in the upper basalt surface during other investigations near the Site (Geraghty & Miller 1991; AMEC 2007).

2.5 HYDROGEOLOGY

Groundwater occurs in six distinct water-bearing zones beneath the Site. These water-bearing zones have been designated as the Shallow Zone, Shallow-Intermediate Silt Zone, Intermediate Zone, Deep Zone, Gravel/Basalt Zone. These water-bearing zones are described in the following sections.

2.5.1 Shallow Zone

Groundwater in the Shallow Zone is unconfined and occurs at depths of approximately 5 to 25 feet bgs in the sand alluvium and the uppermost fill. In general, the depth to groundwater increases from west to east across the Site. The saturated thickness of the Shallow Zone is defined as the depth from the top of the water table to the upper surface of the Shallow-Intermediate Silt Zone, and ranges from approximately 2 to 15 feet near the bank of the Willamette River to approximately 15 to 25 feet near Front Avenue. The saturated thickness in areas to the west of Front Avenue ranges between 0 and approximately 15 feet.

2.5.2 *Shallow-Intermediate Silt Zone*

The Shallow Zone is underlain by the Shallow-Intermediate Silt Zone. This zone comprises silts, sandy silts, and clays and acts as an aquitard between the Shallow Zone and Intermediate Zone. This layer is approximately 1 to 4 feet thick across the Site and is discontinuous in the southern portion of the Site (i.e., in the former Chlorate Manufacturing area). The Shallow-Intermediate Silt Zone tends to increase in thickness to the west of the Site, with the thickest portions (up to 45 feet) located in the former Doane Lake area.

2.5.3 *Intermediate Zone*

The Intermediate Zone consists of the alluvial sands below the Shallow-Intermediate Silt Zone. The groundwater in the Intermediate Zone is confined or semi-confined and occurs between depths of approximately 36 to 46 feet bgs with a saturated thickness of approximately 5 to 10 feet across the Site. The Intermediate Zone is discontinuous in the northwestern portion of the Site (Doane Lake area).

2.5.4 *Deep Zone*

Groundwater in the Deep Zone occurs in the finer-grained deposits below the alluvial sands and above the Columbia River Basalt. Below the sands at depths from approximately 40 to 60 feet bgs, silt with some clay and fine sand is predominant. The depth and saturated thickness of the Deep Zone (up to approximately 60 feet) is controlled by the topography of the basalt bedrock.

2.5.5 *Gravel/Basalt Zone*

In the northern portion of the Site (Lot 1), alluvial gravel is present between the Deep Zone and the basalt bedrock. The Gravel Zone is approximately 10 feet thick and tends to increase in thickness with proximity to the Willamette River. The Gravel Zone and the underlying Basalt Zone are generally referred to as the Gravel/Basalt Zone.

The extent of this Gravel Zone throughout the Site is still being investigated. Additional investigations and interpretations could lead to some revision of the extent of the Gravel Zone, particularly in the northern portion of the Site. The Gravel Zone has a significantly higher hydraulic conductivity than the overlying Deep Zone, and has been identified as a potential pathway of contaminant migration from the Rhone-Poulenc site (AMEC 2010). The Rhone-Poulenc site abuts Lots 1, 2, and 3 of the former Arkema facility south of Front Street.

2.6 SURFACE WATER

The Site is located along the west bank of the Willamette River at approximately river mile 6.9 to 7.6. The confluence of the Willamette and Columbia rivers is approximately 7.5 miles northwest of the Site. The minimum monthly river stage along the Willamette River in the Portland Harbor area typically occurs between July and October (U.S. Army Corps of Engineers 2004). Maximum monthly stages usually occur in the winter between December and February and in the spring between March and June, coincident with flood peaks on the Willamette and Columbia rivers.

The Willamette River stage is influenced by upstream reservoir regulation on both the Willamette and Columbia rivers (up to the Bonneville Dam) and by tidal effects from the Pacific Ocean (U.S. Army Corps of Engineers 2004). Tidal effects are most pronounced (i.e., ranging from 2 to 3 feet in amplitude per tidal cycle) when the river stage is less than about 8 feet (North American Vertical Datum of 1988 [NAVD88]). Tidal influences are more moderate (i.e., less than 2 feet in amplitude) between river stage elevations of 13 to 19 feet NAVD88. Above approximately 19 feet, tidal fluctuations are generally absent in the Portland Harbor. Tidal influences are most pronounced during the summer and fall when river flow and river stage are typically at their lowest.

The area around the Site was once dominated by lakes, including Doane Lake. Much of the original Doane Lake was filled with hydraulic dredge material, as well as rocks, gravel, sand, and other material up to depths of approximately 40 feet bgs. The remnant of Doane Lake was further divided into two bodies, North Doane Lake and West Doane Lake, by the placement of fill during the construction of the Burlington Northern Santa Fe railroad. The lakes are underlain by thick lacustrine deposits of silts and clays. The surface water in both lakes is connected to the groundwater (AMEC 2010).

2.7 DETERMINATION OF BENEFICIAL WATER USE

A land and beneficial water use determination in the LOF was conducted as part of the RI Report (ERM 2005). For the purposes of the upland investigation and this report, the LOF is assumed to be the Arkema

property and the riverbank to the ordinary high Willamette River water level.

Information regarding use of water potentially affected by former manufacturing operations was collected as part of the Phase 2 Site Characterization (CH2M Hill 1997) and a beneficial water use survey conducted for a nearby facility (Woodward-Clyde 1997). Potential beneficial uses of nearby surface water (the Willamette River) include industrial use, recreational use, and ecological habitat in the LOF.

No drinking water wells are located on or near the LOF. Groundwater is not currently used, nor is it reasonably likely to be used in the future, as a drinking water source. A survey of wells within a 1-mile radius of the Site was conducted by CH2M Hill (CH2M Hill 1997). This survey identified wells within the search radius of the Site but concluded that there were no water supply wells identified downgradient of the Site. An updated inventory of wells situated within a 1-mile radius of the facility was conducted for the RI Report (ERM 2005). No new water supply wells were identified within the search radius. Because of the proximity of the Site to the Willamette River, future industrial water needs (e.g., non-contact cooling water) are likely to be met by surface water or, to a limited potential extent, the basalt aquifer. The potential beneficial uses for groundwater in the LOF include recharge to the Willamette River and the basalt aquifer. The potential beneficial uses of nearby groundwater in the basalt aquifer include recharge to the Willamette River and industrial water supply. Potential impacts from the upland area and associated groundwater on the adjacent river environment were evaluated in the human health and ecological risk assessments (ERAs), as discussed in Section 4.0.

2.8 REGULATORY BACKGROUND

In 1998, Arkema entered into a voluntary agreement with the ODEQ under the Oregon Voluntary Cleanup Program to address impacts to environmental media associated with the manufacture of DDT in the Acid Plant Area and sediment in the Willamette River adjacent to the Site. ODEQ approved the *Upland Remedial Investigation Report Lots 3 & 4 and Tract A – Revision 1* (RI Report) (ERM 2005) on 5 June 2006. The RI Report describes details of the Site and the nature and extent of contamination.

In June 2005, Arkema entered into a non-time-critical removal action administrative settlement with the United States Environmental Protection Agency (USEPA) (Early Action)¹ to address near-shore sediment impacts at the Site. The Statement of Work for the Early Action required, among other things, the preparation and delivery of an Engineering Evaluation/Cost Analysis (EE/CA) Work Plan to identify

and provide alternatives for addressing the primary chemicals of concern (COCs) in the intertidal area and submerged lands on and adjacent to the Site. The draft EE/CA was submitted to the USEPA on 26 July 2012 (Integral 2012). Agency comments on the EE/CA were received on 11 February 2013. Responses were submitted on 28 March 2013. This Early Action order was terminated on March 30, 2016.

The following are other significant milestones in the administrative record:

- In 2008, Arkema and the ODEQ entered into the Consent Order for the upland portion of the Site. The upland Consent Order requires submittal of various documents in support of upland source control (i.e., groundwater, stormwater, and erodible soil) and the upland FS (data gap investigation, risk assessment, HSE, and FS Work Plan and FS)
- The upland *Human Health Risk Assessment, Arkema Site: Upland Areas* (Integral 2008c) was approved by the ODEQ on 5 March 2009. The *Arkema Upland Level II Screening Ecological Risk Assessment* (Level II Screening ERA) (Integral 2009a) was conditionally approved by the ODEQ on 15 March 2010.

¹ *Administrative Order on Consent for Removal Action*, USEPA Region 10, Docket No. CERCLA 10-20050191 (27 June 2005).

- The *HSE Update* (ERM 2012a) was submitted on 13 January 2012. ODEQ comments on the *HSE Update* were received on 28 June 2012. Subsequent revisions to the determination of hot spots are incorporated into this FS Work Plan. The revised determination of hot spots is discussed in Section 4.3.
- A *Draft Groundwater Source Control Evaluation* was submitted to the ODEQ in 2007 (Integral 2007a), and an addendum was submitted in 2008 (Integral 2008a). The source control screening evaluation (SCSE) concluded that implementation of the Groundwater SCM would prevent contaminant flux to the Willamette River, as required by the Joint Source Control Strategy (JSCS)². In May 2008, LSS submitted the *Draft Focused Feasibility Study, Groundwater Source Control Interim Remedial Measure* in support of the Groundwater SCM at the Site (ERM 2008a). The focused feasibility study (FFS) provided an evaluation of remedial alternatives and selected the preferred alternative for the Groundwater SCM.
- On 23 February 2009, the ODEQ approved the general approach for the Groundwater SCM. This approach included installation of a groundwater barrier wall and a GWET system, with treated water discharged to the Willamette River. The ODEQ approved the *Groundwater Barrier Wall Final Design* (ERM 2012b) on 7 August 2012. Construction of the groundwater barrier wall began in May 2012 and was completed in December 2012. The ODEQ approved the *Arkema Portland Groundwater Source Control Measure Groundwater Extraction and Treatment System Final Design* (ERM 2013) on 2 April 2013. Construction of the GWET system began in December 2012 and was completed in December 2013. The design and implementation of the Groundwater SCM are summarized in Section 3.6.1.

Between September 2000 and November 2006, several stormwater interim remedial measures (IRMs) – including soil removal, temporary capping, and best management practices (BMPs) – were implemented at the Site to address stormwater (Integral 2007b). However, because the planned Groundwater SCM required a substantial modification and rerouting of the existing stormwater system, LSS agreed to further enhance the stormwater BMPs. LSS subsequently began preparing a Stormwater FFS to evaluate additional stormwater IRMs (Integral 2008b). Following negotiation and response to comments on the Stormwater IRM FFS, LSS began designing the Stormwater SCM with preparation of the Design & Implementation Work Plan (Integral 2009b). Subsequent to this submittal, the ODEQ and Arkema entered into the Memorandum of Agreement and Order (MAO), which was executed on 4 August 2010.

² The Portland Harbor JSCS prepared by the ODEQ and USEPA (ODEQ 2005) is a framework for making decisions on upland source control at the Portland Harbor Superfund Site.

The *Final Design Report Stormwater Source Control Measures* (Integral 2011) was submitted on 30 September 2011 and approved by the ODEQ on 21 December 2011. Construction of the Stormwater SCM began in April 2012 and was complete in December 2012. The design and implementation of the Stormwater SCM are summarized in Section 3.6.2.

Stormwater SCM performance monitoring began in December 2012. Beginning in 2013, monthly discharge monitoring reports and annual performance monitoring reports have been provided to ODEQ. The design report, monthly monitoring reports, and performance monitoring reports were prepared pursuant to 1) the Order on Consent requiring SCMs issued by the ODEQ and signed 31 October 2008 (ODEQ No. LQVC-NWR-08-04), and 2) the stormwater MAO (No. WQ/I-NWR-10-175) executed by ODEQ and LSS (as agent for Arkema) on 4 August 2010.

3.0 SUMMARY OF PREVIOUS INVESTIGATIONS AND SOURCE CONTROL MEASURES

This section summarizes the previous investigations and interim SCMs implemented at the Site.

3.1 SUMMARY OF THE RI REPORT

Historical Site activities and potential sources of COCs were previously described in detail in the RI Report (ERM 2005). Site activities and potential sources are summarized in this section for convenience.

Chemical manufacturing at the Site occurred on Lots 3 and 4 in the Chlorate Plant Area and Acid Plant Area. Inorganic chemicals—including sodium chlorate, chlorine, sodium hydroxide, hydrogen, and hydrochloric acid—were manufactured at the plant from 1941 to 2001. DDT was manufactured at the Site from approximately 1947 to 1954.

Based on historical activities, potential source areas of COCs within the Chlorate Plant Area include the following:

- Chlorate Cell Room;
- Chlorate Process Building;
- Chlorate Warehouse; and
- Chlorate Tank Farm.

Potential COCs from sources within the Chlorate Plant Area include the following:

- Hexavalent chromium (Cr[VI]);
- Perchlorate; and
- Chloride.

DDT was manufactured in the Acid Plant Area. Discrete areas within the Acid Plant Area that are potential sources of COCs include the following:

- Former Manufacturing Process Residue (MPR) Pond and Trench;
- DDT Process Building;
- Monochlorobenzene (MCB) Recovery Unit;
- DDT Dry Storage area; and
- Possible DDT Loading areas.

Based on historical operations, potential COCs from Acid Plant Area activities include the following:

- Organochlorine pesticides (DDT, co-metabolites dichlorodiphenyldichloroethane [DDD], and dichlorodiphenyldichloroethene [DDE], hereafter referred to collectively as DDx);
- Volatile organic compounds (VOCs) (primarily MCB and chloral); and
- Perchlorate.

The following additional areas (and potential COCs) were investigated as part of the RI and supplemental investigations:

- Salt Pads (chloride);
- Old Caustic Tank Farm (OCTF) (sodium hydroxide, petroleum hydrocarbons, and DDx);
- Former Ammonia Plant (aqueous ammonia);
- Former Transformer Pads (polychlorinated biphenyls [PCBs]);
- Bonneville Power Administration (BPA) Main Substation (PCBs);
- Stormwater Drain System (pesticides, semi-volatile organic compounds [SVOCs], perchlorate, and chloride); and
- Former Cell Repair Room (dibenzofurans).

A summary of the investigations conducted in each of these additional areas is presented in the following sections.

3.1.1 Salt Pads

The RI/FS Work Plan did not originally include investigation of the salt pads. This investigation was initiated as a result of the Preliminary Assessment (PA) (Elf Atochem 1999), Expanded PA (Elf Atochem 2000), and chloride concentrations in Site groundwater. The salt pads are situated within the Chlorate Plant Area and share many of the same groundwater sampling locations. Chloride is the only potential COC associated with the salt pads. Investigation activities carried out to characterize impacts of the salt pads consisted of monitoring well groundwater sampling in conjunction with the Chlorate Plant Area groundwater investigation and implementation of subsequent IRMs (discussed in Section 3.5.1).

Chloride was observed in groundwater at all salt pad area wells during all sampling events. Chloride is a naturally occurring ion in groundwater; however, elevated chloride concentrations were observed on the downgradient side of the former salt pads where salt was stockpiled and salt brine was produced for use in manufacturing.

While the highest concentrations of chloride exist in the vicinity of the downgradient edge of the salt pads area, chloride concentrations exist Site-wide in all groundwater zones above the preliminary screening level of 230 milligrams per liter (mg/L). This is likely due to the ubiquitous use of brine in the manufacturing processes that took place during facility operations. Chloride has been observed in the most upgradient Shallow - Intermediate Zone monitoring wells, indicating a potential additional source of chloride that is upgradient and off site.

3.1.2 Old Caustic Tank Farm

The RI/FS Work Plan did not originally include investigation of the Chlorate Plant Area. After removal of the tanks during Site demolition, Arkema collected and analyzed samples to characterize tank sub-base soil. Based on historical operations, potential COCs associated with the OCTF include the following:

- Sodium hydroxide (caustic);
- pH;
- Total petroleum hydrocarbons (TPHs); and
- Organochlorine pesticides.

Potential sources of these COCs in the OCTF include the following (see Figure 2-2):

- The aboveground storage tanks; and
- Operations in the neighboring Acid Plant Area.

Investigation activities completed in the OCTF were limited to surface soil sampling, including composite and discrete samples.

The results of the OCTF sampling were reported in the *Soil Sampling and Analysis Report; Old Caustic Tank Farm; ATOFINA Chemicals, Inc. Portland Facility* letter report, dated 20 July 2004 (ERM 2004) and the RI. Soil samples were analyzed for organochlorine pesticides, VOCs, metals, polycyclic aromatic hydrocarbons (PAHs), and TPH. Only pesticides

(DDT, DDD, and DDE) were detected at concentrations exceeding the preliminary screening levels.

There have been two known historical releases of sodium hydroxide in the OCTF. No specific groundwater investigation was conducted as a result of these releases; however, pH and alkalinity have been measured in the field and laboratory, respectively, in groundwater samples collected from the neighboring Acid Plant and Chlorate Plant Areas to characterize any impacts of caustic releases. Slightly elevated pH was observed in several crossgradient and downgradient wells, including MWA-24 and MWA-42 (ERM 2010a).

3.1.3 *Ammonia Plant*

A release of 400 gallons of a 30-percent anhydrous ammonia solution led to an investigation to determine if the groundwater had been impacted. Two direct-push borings were advanced near the former Ammonia Plant to collect groundwater samples (borings B-67 [downgradient] and B-119 [upgradient]). In addition, groundwater samples were collected from two monitoring wells in the Acid Plant Area (MWA-5 and MWA-14i). Ammonia was detected at all four sample locations.

Concentrations up to 20 mg/L were detected during the investigation at well MWA-5 (April 2002). Groundwater samples collected from the direct-push borings contained ammonia at concentrations of 2 mg/L (boring B-119, June 2002) and 1.22 mg/L (boring B-67, May 2001). Data presented in a report prepared for the Rhone-Poulenc property indicate that ammonia is present in groundwater at concentrations up to 34.5 mg/L in the monitoring well cluster W-04 situated across Front Avenue from the Arkema property, upgradient of the former Arkema Ammonia Plant and monitoring well MWA-5 (Woodward-Clyde 1997). Based on this data, the former Arkema Ammonia Plant is not considered a source of ammonia in Site groundwater.

In a letter dated 21 March 2002, ODEQ agreed that the data from the upgradient monitoring wells indicated that it is likely that ammonia has migrated with groundwater onto Arkema's property (ODEQ 2002). In that letter, ODEQ also stated that Arkema was required to perform additional sampling before application of the Contaminated Aquifer Policy (ODEQ 1997).

Arkema reviewed conditions A through D of the Contaminated Aquifer Policy and concluded that, based on the analytical results for ammonia in the direct-push boring groundwater samples collected upgradient and

downgradient of the former Ammonia Manufacturing Plant and analytical results from off-site, upgradient wells screened in the same groundwater bearing zones, the Contaminated Aquifer Policy applies to ammonia at the Site. Based on this determination, no additional evaluation of risk posed by ammonia impacts to groundwater or potential remedial actions has been conducted. However, ODEQ has stated that additional investigation of the former Ammonia Plant must be completed before application of the Contaminated Aquifer Policy.

3.1.4 *Transformer Pad Concrete Sampling*

Based on the prior operational use of potentially PCB-containing transformers at the Site, Arkema conducted an investigation of the former transformer pads after the transformers had been removed during demolition activities. The investigation consisted of the collection and analysis of concrete chip samples from concrete pads where potentially PCB-containing transformers were known or suspected to have been located.

The highest PCB concentration detected in the concrete pads was 2.165 milligrams per kilogram (mg/kg). According to 40 Code of Federal Regulations Part 761, a PCB-contaminated material is a non-liquid with PCB concentrations greater than 50 mg/kg. Based on the sampling results, the concrete pads are not considered a source of PCB contamination at the Site and were not carried forward in the risk assessment.

3.1.5 *Bonneville Power Administration Main Substation*

PCBs were detected in soil during a Phase II Environmental Site Assessment conducted by the BPA in the BPA Main Substation (referred to as the Pennwalt Substation) (PBS 2002a). PCBs were detected in shallow soil (0 to 5 feet bgs) at concentrations up to 1.25 mg/kg. In addition to PCBs, TPH, seven PAHs, lead, DDT, and DDD were detected at low concentrations in soil samples collected in the substation area (PBS 2002a).

Soil samples collected in stormwater drainage swales north and south of the substation did not contain PCBs above the detection limit of 0.05 mg/kg. Soil excavated from the northwestern corner of the former substation contained the highest observed concentrations of PCBs. Confirmation samples indicated that soil containing PCBs at concentrations up to 4.5 mg/kg remain on Site within the former substation. Samples collected in the area between the substation and NW Front Avenue indicated that PCB concentrations in soil are less than

0.91 mg/kg. Based on these results, PCBs were included in the list of COCs for evaluation in the HHRA and ERA. For the purposes of performing a risk assessment and FS, the available data have adequately defined the extent of impacts in the Pennwalt Substation.

3.1.6 *Stormwater System*

DDT was detected in five of eight samples collected from two manholes during early stormwater characterization work in the Acid Plant Area in 1999. DDD and DDE were not detected in any of the eight samples. Total DDT and its metabolites were detected in all but one of the stormwater samples. Significant reductions in total DDT and metabolite concentrations in stormwater were observed after the Phase I Soil IRM (discussed in Section 3.4.1) was completed; total DDT concentrations were approximately half of what had been previously observed; and DDT metabolite concentrations were approximately an order of magnitude less than previously observed levels.

ODEQ issued Arkema a new National Pollutant Discharge Elimination System (NPDES) discharge permit for stormwater on 22 January 2004. Conditions of the permit required Arkema to conduct a stormwater characterization for legacy and 303(d) constituents for a 1-year period and submit a report to ODEQ summarizing the sampling and results. The stormwater characterization work consisted of monthly monitoring in Outfalls 001, 002, 003, and 004.

Organochlorine pesticides were detected in all four outfalls throughout the 1-year sampling program. Cr[VI] was detected in Outfall 004 in several of the monthly samples. In an effort to delineate the source of pesticides and Cr[VI] in the outfall samples, Arkema collected additional stormwater data, which included several locations within each of the four storm drain systems. Phase III demolition activities were carried out concurrently with the monthly monitoring. Several constituents exhibited temporary increases during this time, decreasing after demolition activities were complete.

Based on the results of the stormwater monitoring during this period and ongoing NPDES permit monitoring, Arkema subsequently implemented a Stormwater SCM for DDT and metabolites in stormwater (Section 3.6.2).

3.2 SUPPLEMENTAL INVESTIGATIONS

This section presents a summary of data generated as part of additional investigations conducted since the RI was submitted in December 2005. These data have been incorporated as appropriate into the HHRA, ERA, and design of SCMs.

3.2.1 *Surface Soil Sampling on Lots 1 and 2*

In March 2006, seven composite soil samples were collected from Lots 1 and 2 in support of additional characterization of shallow soils. The results of this investigation were previously reported to the ODEQ (ERM 2006a). Four discrete locations were sampled from the surface (0 to 1 feet) for each composite. Samples were analyzed for organochlorine pesticides, PCBs, SVOCs, total petroleum hydrocarbon-diesel (TPH-D), total petroleum hydrocarbon-gasoline (TPH-G), arsenic, cadmium, chromium, lead, and zinc. These data were included in the subsequent HHRA and ERA.

3.2.2 *Supplemental 2007 Riverbank Soil Sampling*

A supplemental riverbank soil sampling investigation was conducted to further delineate the extent of contamination in support of the terrestrial Level II Screening ERA per ODEQ's direction (Integral 2009a). In March 2007, surface (0 to 6 inches) soil samples were collected from 13 riverbank stations (Stations RBC-1 through RBC-13) along the entire property boundary, with the exception of the area between Docks 1 and 2, which had been adequately sampled during previous sampling events. The stations were located near the top of the bank, as well as between the top of bank and mean high water (approximately 12 feet NAVD88). A single composite sample made up of five discrete samples was collected from each station. In addition, five deeper (18 to 24 inches) soil samples were collected from select riverbank stations to characterize the shallow subsurface. A total of 14 surface composite (including one field duplicate sample) and 5 subsurface samples were collected and analyzed for organochlorine pesticides, SVOCs, PCBs, chlorinated dioxins (CDD), chlorinated furans (CDFs), total TPH-D, total TPH-G, VOCs (analysis conducted on two samples that demonstrated the possible presence of volatile organics by photoionization detector field screening), and total metals (arsenic, cadmium, chromium, lead, and zinc). These data were incorporated into the Level II Screening ERA and have been subsequently used in the HSE in this Work Plan (Section 4.3).

3.2.3 Upland Groundwater CDD/CDF Sampling

In August 2006, 11 groundwater samples were collected from areas within and downgradient of the former Acid Plant and Chlorate Manufacturing Areas to assess whether these are potential upland CDD/CDF sources that require remediation (e.g., source control). The investigation was implemented in accordance with an ODEQ request, and the results of the investigation were reported to the ODEQ (ERM 2006d). The investigation results showed limited detections, which were below many of the Portland Harbor JSCS screening values. ~~The data indicate that the groundwater at the Site does not represent a source of dioxins or furans to the transition zone pore water. Therefore, CDD/CDFs in groundwater in the former Acid Plant Area and Chlorate Manufacturing Area do not represent a significant risk to surface water or sediment and do not require remedial measures or warrant additional evaluation. However, a~~ As directed by ODEQ, these results have been included into the Work Plan and the hot spot screening evaluation.

3.2.4 Site-Wide Groundwater Sampling

Site-wide groundwater monitoring was conducted in April 2007 (ERM 2007). The purpose of this sampling was to obtain comprehensive Site-wide data after implementing the groundwater IRMs (discussed Section 3.5) that could be incorporated into the HHRA and ERA and used in the design of the Groundwater SCM.

A second Site-wide groundwater sampling event was conducted in August 2009 (ERM 2010a). The purpose of this event was to:

- Collect data to support an evaluation of the updated CSM for CDD/CDFs at the Site (discussed in Section 3.3.1);
- Collect data to support the final design of the Groundwater SCM (Section 3.6.1);
- Collect data to fill data gaps sufficient to evaluate remedial technology alternatives in the uplands FS; and
- Provide additional information regarding the migration (fate and transport) of contaminants from the upgradient Rhone-Poulenc facility (across NW Front Avenue) onto the Site.

LSS proposed using only the August 2009 data as the most representative data for the purpose of conducting the HSE (ERM 2012a) and the FS. As directed by ODEQ, LSS is required to use the maximum concentration from the 2006 Upland Groundwater Dioxin/Furan Sampling (ERM

2006d), April 2007 Sitewide (ERM 2007), August 2009 Sitewide (ERM 2010a), and the ~~January 2009/~~2010 Rhone-Poulenc (AMEC 2010) groundwater monitoring events data for the purpose of delineating preliminary groundwater hot spots. LSS disagrees with this approach because it comingles data that are between 7 and 11 years old. LSS has done the ODEQ-requested screening in the revised hot spot analysis for this Work Plan. ~~For the FS, LSS expects to use the most recent data or newly collected data to define groundwater hot spots.~~

The results of the 2006 Upland Groundwater Dioxin/Furan Sampling (ERM 2006d), April 2007 Sitewide (ERM 2007), August 2009 Sitewide (ERM 2010a), and the January 2010 Rhone-Poulenc (AMEC 2010) groundwater monitoring data confirmed the previously determined extent of COCs in the former Acid Plant Area and the Chlorate Plant Area for contaminants such as perchlorate, chloride, chlorobenzene, DDx, and Cr[VI]. These contaminants are predominately localized on Lot 4.

Constituent concentrations on Lots 1, 2, and a large portion of Lot 3 increase with depth and are the result of impacts from off-site source(s). The April 2007 and August 2009 results confirmed that contaminant migration from off-site sources of chlorinated VOCs, 1,2-dichlorobenzene, chloride, herbicides, pesticides (including Lindane), PCBs, and CDD/CDFs onto Lots 1, 2, and a large portion of Lot 3 is occurring. Interim SCMs, such as repair of the Outfall 22B storm sewer, have been implemented to attempt to prevent groundwater interception and control further migration of contaminants from the Rhone-Poulenc facility to the Willamette River. LSS notes that the sealing of the city sewer line will exacerbate the flow of Rhone-Poulenc contamination onto the Site, as the storm sewer will no longer intercept contaminated groundwater.

Under ODEQ guidance, StarLink Logistics Inc. (SLLI)/Rhone-Poulenc is currently implementing an SCM for groundwater contamination in the Gravel/Basalt Zone. SLLI/Rhone-Poulenc submitted a revised Source Control Evaluation (AMEC 2010) to delineate the nature and extent of the impacts in groundwater from the Rhone-Poulenc facility. In 2015, ODEQ prepared an addendum to the RI-SCE (ODEQ 2015). ODEQ concluded that primary and secondary sources of contaminant releases from the Rhone-Poulenc facility have resulted in extensive groundwater contamination to surrounding areas. These impacts in groundwater are present in the alluvial water bearing zones (i.e., Shallow, Intermediate, and Deep Zones) as well as the Gravel/Basalt Zone. Impacts extend across NW Front Avenue onto the Site and reach the Willamette River (ODEQ 2015). COCs from the Rhone-Poulenc site extending onto the Site include VOCs, SVOCs, pesticides, insecticides, and CDDs/CDFs. DNAPL

also likely extends from the Rhone-Poulenc facility to the Willamette River.

LSS will use the maximum of concentration from the Arkema 2006, 2007, 2008, 2009 and 2009/2010 Rhone Poulenc ~~2007 and 2009~~ groundwater data to screen groundwater hot spots in this Work Plan, as specified by ODEQ. ~~LSS believes that DEQ's request is based on the premise that there will be no additional groundwater monitoring before the FS.~~ The existing data, however, are more than 8 years old and ~~are likely not~~ may not be representative of current conditions. As agreed by the ODEQ in a 24 August 2017 meeting, LSS ~~will~~ may propose a new round of groundwater monitoring that, ~~if available in time, may be incorporated into the FS; otherwise, the new data will~~ can be incorporated into subsequent pre-design submittals. The results of future groundwater sampling events may change the delineation of remediation areas as compared to areas delineated in this Work Plan.

The delineated extent of groundwater hot spots for COCs is discussed further in Section 4.3. In accordance with the ODEQ-directed hierarchy for hot spot screening (see Section 4.3 and Appendix A), any detectable concentration of certain COCs, including DDx, is above the applicable hot spot criterion. Based on the ODEQ criteria, the northern and western (upgradient) extent of groundwater hot spots extend to the Site boundary.

LSS believes that the ODEQ-directed screening criteria for DDx hot spots in groundwater is an inappropriate application of the surface water AWQC, because any detection screens in. Accordingly, ~~it cannot be known whether~~ the northern extent of these hot spots in groundwater are outside of ~~is bounded by~~ the hydraulic influence of the groundwater SCM. The hot-spot screening hierarchy that applies ambient water quality criteria (AWQC)³ as very conservative groundwater criteria may delineate hot spots that are larger than can be physically and scientifically attributable to the Site. As noted above, contaminants including chlorinated VOCs, 1,2-dichlorobenzene, chloride, herbicides, pesticides, PCBs, and CDD/CDFs are being transported from off site onto Lots 1, 2, and a large portion of Lot 3.

3.2.5 Rhone-Poulenc January 2010 Groundwater Sampling

On behalf of SLLI, AMEC Earth & Environmental, Inc. (AMEC), conducted groundwater monitoring in January 2010 at select monitoring wells on the Arkema property. Results from this sampling were reported

³ In this document the term "AWQC" refers collectively to freshwater aquatic life or human health risk-based criteria promulgated by the ODEQ and USEPA and specified by ODEQ in the hierarchy of values to screen groundwater hot spots. See Appendix A.

in the Source Control Evaluation (AMEC 2010). This sampling program was focused on wells installed on the Arkema property to characterize the RP plume. The wells sampled included upgradient boundary wells along NW Front Avenue and wells located in Lots 1 and 2 that are screened in the Shallow, Intermediate, Deep, and Basalt Zones. At ODEQ's direction, these results have been included in the groundwater data set used to delineate hot spots in this Work Plan.

3.3 DATA GAPS INVESTIGATION

A soil investigation was conducted in January 2010, and the results were reported in the *Data Gaps Investigation Report* (ERM 2010b). The purpose of the data gaps investigation was to achieve the following objectives:

- Identify and fill data gaps sufficient to evaluate remedial technology alternatives in the uplands FS.
- Collect data to update the CSM for CDDs and CDFs.
- Evaluate the presence/absence of polychlorinated naphthalenes (PCNs) and octachlorostyrene (OCS).

Eight borings were advanced in the followings areas of the Site:

- Old Chlorine Cell Room and associated cell repair room;
- Former River Bank Brine Residue Pond;
- Former River Bank Asbestos Pond;
- Former Diamond Cell Room Asbestos Ponds; and
- Former Diamond Cell repair room.

A revised CSM for CDD/CDFs was presented in the *Draft Data Gaps Assessment Work Plan* (ERM 2009a) and the *Former Arkema Portland Plant Addendum to Data Gaps Assessment Work Plan* (LSS 2009). This revised CSM is summarized below.

3.3.1 Revised CDD/CDF Conceptual Site Model

The results of the data gaps investigation support the updated CDD/CDF CSM. Sufficient data has been collected to identify the potential source areas (i.e., Old Chlorine Cell Room) at the Site. The purpose of the data gaps soil sampling (ERM 2010) was to identify and fill data gaps as needed to evaluate remedial alternatives in the upland feasibility study.

The investigation showed no detectable OCS and PCNs; therefore, no additional assessment of these potential COCs is warranted.

The data gaps sampling (ERM 2010b) indicated that the vertical extent of CDF impacts is limited to shallow soils, from 0 to 2 feet bgs. This is consistent with the release of CDFs in wastes generated during historical graphite anode cell maintenance activities as well as atmospheric deposition from neighboring facilities; impacts are localized and associated with the Old Chlorine Cell Room Area.

LSS has also performed a detailed analysis of the chlor-alkali process to determine if Site-specific proprietary technologies and processes were capable of producing CDD/CDFs (Waterstone 2012). The report ~~is~~ was included as Appendix B of the November 2017 Draft FS Work Plan. The conclusion of the report confirms that the chlor-alkali process was not a source of OCS, PCNs, or PCBs. The Gibbs chlorine cells (used from 1946 until 1971) had the potential to form CDFs and to a much lesser extent CDDs. (Waterstone 2012). ~~It is unlikely that the cells used at the Site produced waste products with significant concentrations of CDDs (Waterstone 2012).~~

The data gaps report stated that debris associated with power pole demolition have contributed to the presence of CDD/CDF in catch basin sediment, as wood debris was noted in 5 of the 11 catch basins tested for CDD/CDF. ODEQ's 7 July 2010 comment letter on the *Data Gaps Investigation Report* agreed with this conclusion. Testing of the power poles indicated high levels of CDD/CDF. ODEQ has also acknowledged that the conceptual site model needs to allow for the possible contribution of off-site sources to Site soils and catch basin sediment. However, ODEQ does not agree that Site operations did not also contribute to CDD/CDF concentrations in Site soils and catch basin sediment.

In its response to the 2013 Draft Work Plan (ODEQ 2017), ODEQ cited the 23 October 2008 letter in which ODEQ concluded that the presence of CDD/CDF indicated the potential presence of CDD/CDF in Site soil. Instead of collecting additional surface soil data, ODEQ agreed to move forward provided this assumption was carried into the FS. Section 4.1.2 of this Work Plan states that "the highest total incremental lifetime cancer risk of 1×10^{-4} was estimated for an outdoor occupational worker under RME conditions." Accordingly, this Work Plan includes additional discussion of potential excess risk to occupational workers from CDD/CDF in surface soils (Section 4.1.2).

3.4 SOIL INTERIM REMEDIAL MEASURES

During RI field activities, evidence of DDT- and MCB-impacted soil was observed in and around the former Acid Plant Area. Soils containing DDT and MCB at elevated concentrations were observed in the following locations: within the former MPR Pond and Trench, in an unpaved area approximately 150 feet west of the MPR Pond and Trench, in the unpaved area immediately north of the former Acid Plant Area, and in the area north of the former MCB Recovery Unit Area and south of Warehouse No. 2. These locations, and subsequent IRM excavation areas, are shown on Figure 3-2. Elevated DDT and MCB concentrations were primarily identified from near ground surface to approximately 8 feet bgs. DDT and MCB were observed at depths of up to 22 feet bgs in the immediate vicinity of the former Acid Plant Area.

In response to these elevated DDT and MCB concentrations, Arkema implemented multiple IRMs to mitigate potential environmental impacts. The purposes of the IRMs were as follows:

- Remove DDT-affected soil to the extent technically practicable.
- Construct Site drainage improvements to ensure proper drainage and reduce ponding of surface water.
- Install limited paving and a temporary surface cover to reduce transport of DDT and MCB resulting from stormwater runoff and erosion of surface soils.

The IRMs targeted DDT concentrations greater than 1,200 mg/kg, which is the human health risk for outdoor worker occupational exposures before implementing IRMs. This targeted concentration, while equivalent to the ODEQ's default "hot spot" criterion for DDT, was used only as a screening value to identify which surface or near-surface soil might need to be addressed by the IRMs. The prior soil IRMs are described in the subsections below.

3.4.1 Phase I Soil Removal

The Phase I Soil Removal IRM was performed between September and November 2000, and focused on excavation and off-site disposal of DDT-affected soil from the former MPR Pond and Trench areas. Excavations were conducted to a maximum depth of 12 feet bgs. Approximately 3,800 tons of soil was excavated and removed as part of the Phase I Soil Removal IRM. Grading, paving, and stormwater conveyance improvements were installed within the excavated area. Additionally, a temporary surface cover – consisting of a visqueen plastic layer between

two layers of geotextile, buried beneath approximately 2 inches of ¾-inch-minus gravel – was constructed in the unpaved area east of the former Acid Plant Area. Further details regarding the Phase I Soil Removal IRM activities were presented in the *Interim Remedial Measures Implementation Report* (ERM 2001).

3.4.2 Phase II Soil Removal

The Phase II Soil Removal IRM was completed in November 2001 and focused on the area north of the former Acid Plant Area and south of Warehouse No. 2. A total of 91 tons of soil were excavated to a maximum depth of 7 feet bgs. Stormwater conveyance improvements and asphalt paving were installed to reduce transport of DDT-affected soil in stormwater runoff. A detailed description of the Phase II Soil Removal IRM activities is presented in the *Phase II Soil Interim Remedial Measure Final Report* (ERM 2002).

The Phase I and Phase II IRMs were effective in removing significant quantities of soil containing DDT and MCB, and reduced the potential for transport of these constituents in shallow soils.

3.4.3 Soil Vapor Extraction Interim Remedial Measure

A soil vapor extraction (SVE) system was installed in December 2000 to extract MCB mass from subsurface soils, thereby reducing MCB concentrations to allow disposal of the soil as a non-hazardous waste during future excavation activities. The system was expanded periodically over the 2.5 years of operation and ultimately included five horizontal extraction wells. The horizontal wells were situated approximately 6 feet bgs. A total of approximately 2,500 pounds of chlorobenzene were removed during the operation of the SVE system (ERM 2003).

Confirmation sampling results revealed MCB concentrations in soil greater than had been previously observed in the former MCB Recovery Unit area. Generally, samples with higher MCB concentrations than those previously observed were located around the SVE system extraction wells. Additionally, MCB dense non-aqueous phase liquid (DNAPL) was observed at one of the confirmation borings. The SVE system was not designed to address DNAPL and, consequently, the system was shut down in March 2003.

3.5 GROUNDWATER INTERIM REMEDIAL MEASURES

Between 2000 and 2006, in response to observation of COCs in groundwater at the Site, Arkema implemented multiple targeted IRMs, including:

- Cr[VI] Reduction IRM;
- Air Sparging (AS)/SVE IRM; and
- Persulfate IRM.

These prior groundwater IRMs are summarized in the subsections below.

3.5.1 Hexavalent Chromium Reduction Interim Remedial Measure

The Cr[VI] Reduction IRM was implemented to treat dissolved Cr[VI] in the former Chlorate Plant Area. This IRM involved in situ reduction of Cr[VI] to trivalent chromium, thereby decreasing the solubility and toxicity of chromium. The objective of this IRM was to reduce the Cr[VI] concentration in groundwater to the extent practicable to achieve the JSCS screening level value (SLV) of 0.011 mg/L in groundwater adjacent to the Willamette River.

The Cr[VI] reduction was achieved by injecting calcium polysulfide (CaSx) into the three uppermost groundwater units (Shallow, Intermediate, and Deep Zones), where previous investigations indicated Cr[VI] was present at elevated concentrations. CaSx injection locations are presented on Figure 3-3. The scope and results of the Cr[VI] reduction IRM are summarized below:

- Injection of a total of 1,387,000 gallons of 3 percent and 120,000 gallons of 10 percent by weight of CaSx into the three uppermost water-bearing units at the Site; and
- The average Shallow Zone concentration decreased from 1.306 to 0.3286 mg/L, the average Intermediate Zone concentration decreased from 0.92 to 0.14 mg/L, and the average Deep Zone concentration decreased from 0.123 to 0.01 mg/L. Although concentrations in the Shallow and Intermediate zones did not achieve the targeted JSCS SLV, the average dissolved Cr[VI] concentrations in the Shallow, Intermediate, and Deep zones were significantly reduced by 75, 85, and 92 percent, respectively, by this IRM.

3.5.2 Air Sparging/Soil Vapor Extraction Interim Remedial Measure

After an investigation was conducted in 2002 to characterize the extent of MCB DNAPL in the Shallow Zone, a study involving the installation, operation, and monitoring of a pilot-scale remediation system, including AS/SVE technologies, was conducted. The pilot study was completed over an approximate 5-month period in 2003 in the area where the majority of residual-phase DNAPL was observed during the 2002 investigation. Based on the successful pilot study (an average 64 percent reduction in groundwater concentrations in 5 months), an AS/SVE IRM was designed and implemented to reduce the mass of MCB DNAPL in the Shallow Zone. The AS/SVE system operated continuously between December 2004 and December 2005.

An MCB DNAPL investigation was conducted in two phases in December 2005 and January/February 2006, respectively. The objective of Phase I was to evaluate the effectiveness of the AS/SVE system approximately 1 year after implementation. To evaluate the ability of the system to remove DNAPL, 17 soil samples were collected from across the treatment area. The objective of Phase II was to delineate the lateral extent and vertical distribution of the DNAPL. Phase II included collecting soil cores from the bottom of the Shallow Zone in 42 locations in the former Acid Plant Area.

DNAPL was observed at 16 of the 17 borings completed during Phase I. Although the frequency of DNAPL observation was not unexpected, the vertical distribution of DNAPL was greater than initially anticipated. Thick zones of DNAPL-impacted soil and thinner zones of saturated DNAPL were observed. The lateral extent of DNAPL observed during Phase II was greater than previously anticipated, extending in a narrow area north of the AS/SVE treatment area. The majority of the DNAPL mass was located at the bottom of the Shallow Zone, immediately above the lower silt that separates the Shallow and Intermediate zones. Smaller amounts of DNAPL were also observed in an upper silt layer within the Shallow Zone at most Phase II sample locations.

Based on the additional DNAPL investigation results, the AS/SVE IRM was determined to not be capable of sufficiently remediating the DNAPL source because of the presence of DNAPL between multiple silt lenses in the Shallow Zone. As a result, the system was shut down and mothballed in March 2006. The *Draft Acid Plant Area DNAPL Sampling Summary Report* (ERM 2006b) recommended evaluating additional options for containing and treating the DNAPL. Based on previous investigation and the results of the AS/SVE IRM, the extent of residual DNAPL appears to be stable and limited to areas generally westward of the top of bank (ERM 2006b). The major portion of the residual DNAPL is located westward of the

recently constructed groundwater barrier wall, as discussed in Section 3.6.1. The following attributes indicate that the DNAPL is likely tension saturated and immobile: the length of time since release (i.e., 55 years); the lack of observed DNAPL beyond the riverbank (Integral 2003); and the thin (less than 0.02-inch) DNAPL thickness at the downgradient toe of the DNAPL plume.

3.5.3 *In Situ Persulfate Oxidation Interim Remedial Measure*

In 2005, the In Situ Persulfate Oxidation IRM was implemented to remediate dissolved MCB and DDx in the Shallow and Intermediate zones within the former Acid Plant Area where the historical MPR pond and MCB Recovery Unit were located. The IRM objectives were to reduce the mass of dissolved MCB and DDx by direct oxidation and subsequently decrease the potential mobility of DDx due to co-solvency with MCB.

Monthly groundwater sampling was completed to evaluate the performance of the IRM from October 2005 to January 2006. MCB and DDx concentrations measured in groundwater samples collected during the performance monitoring fluctuated. Similar results were observed in performance monitoring data for the concurrently running AS/SVE IRM described above. The In Situ Persulfate Oxidation IRM was suspended in April 2006 pending evaluation of source control alternatives for upland groundwater as a whole.

3.6 *SOURCE CONTROL MEASURES*

This section presents a summary of the SCMs that are currently being evaluated, or have been implemented, at the Site.

3.6.1 *Groundwater Source Control Measure*

Arkema implemented several in situ interim soil and groundwater SCMs between 2000 and 2006. The results of these SCMs have been presented to the ODEQ and are summarized in Section 3.5. Despite the success of those IRMs, Arkema did not believe an in situ remedial approach would be capable of meeting the source control objectives; therefore, an alternative strategy of physical and hydraulic containment to achieve groundwater source control was pursued.

The goal of the Groundwater SCM is to establish hydraulic control of COCs in groundwater at the Site and maintain an inward groundwater gradient towards the upland portion of the Site, away from the Willamette River. The Groundwater SCM consists of a conventional slurry barrier wall and a GWET system.

The Groundwater SCM is designed to achieve the following RAOs:

- Establish hydraulic control of COCs in groundwater from Lots 3 and 4 at the Site to the Willamette River.
- Reduce the potential for recontamination of river sediments via the groundwater pathway.
- Implement a remedy that, to the extent practicable, will complement and be compatible with potential final upland remedies for the Site.

The Groundwater SCM consists of the following primary components:

1. A containment barrier wall to physically separate the affected upland portions and in-water portions of the Site;
2. Hydraulic control (“groundwater extraction and treatment”) via a series of pumping wells to prevent groundwater containing unacceptable concentrations of COCs from moving around, over, or under the containment barrier wall; and
3. Management of treated groundwater through the ex-situ treatment system described above.

The Groundwater SCM layout is presented on Figure 3-1. The installation of the slurry backfill groundwater barrier wall was substantially completed in December 2012. Construction of the GWET system was substantially completed in December 2013. GWET system startup was initiated May 2014.

3.6.2 Stormwater Source Control Measures

Between September 2000 and November 2006, several stormwater IRMs, including soil removal, temporary capping, and BMPs, were implemented at the Site to address stormwater (Integral 2007a). These stormwater IRMs included:

- September and November 2000: Phase I Soil Removal IRM, described above in Section 3.4.1, was completed in the former Acid Plant Area, including stormwater conveyance improvements, soil excavation and

disposal, and temporary capping activities designed to reduce DDT loading in stormwater.

- November 2001: Phase II Soil Removal IRM, described above in Section 3.4.2, was completed in the former Acid Plant Area, including soil excavation and disposal, capping, and the installation of a storm drain to collect stormwater drainage.
- October to December 2006: BMPs were implemented, including catch basin cleaning, installation of new filter socks and biobags, and sealing pipes in catch basins that were not needed after the Acid Plant was demolished (Lots 3 and 4).

As discussed in Section 3.6.1, because the planned Groundwater SCMs were going to require a substantial modification and rerouting of the existing stormwater system, LSS further enhanced the stormwater BMPs at the Site by implementing a Stormwater SCM. The Stormwater SCM consisted of the following components:

- Capping portions of the drainage basins that have concentrations of COCs in potentially erodible surface soil as an erosion control measure;
- Decommissioning the existing stormwater collection system to eliminate the potential for migration of COCs; and
- Rerouting stormwater via a new surface conveyance system (berms and swales) and treating stormwater runoff from the Site using detention and filtration with discharge through an existing outfall equipped with a diffuser (Outfall 004).

The ODEQ approved the Stormwater SCM final design in a memorandum dated 21 December 2011. The Stormwater SCM layout is presented on Figure 3-1. Construction of the Stormwater SCM was substantially complete, and sampling of the effluent from the stormwater SCMs began in December 2012. Sampling of the influent to the detention and filtration treatment portion of the stormwater SCMs began in February 2013.

Overall, the SCM removal performance for 4,4-DDT has been high. DDx concentrations have decreased since startup of the SCM, and concentrations have been below effluent goals in 12 of the last 14 monitoring events from October 2014 through April 2017. DDx was not detected above effluent goals in any of the effluent samples collected during the 2016 to 2017 monitoring period. These results demonstrate that the stormwater SCM is currently achieving performance objectives.

3.6.3 Riverbank Source Control Measures

A Draft River Bank Erodible Soil Source Control Screening Evaluation (SCSE) was submitted in December 2008 (ERM 2008b). Based on the source control screening and weight-of-evidence evaluation, LSS reached the following conclusions:

- DDx in the area of Dock No. 2 (samples RB-9 and RB-10) was considered a medium priority.
- DDx in the remainder of the river bank was considered a low priority.
- Furan congeners were considered a low priority. However, the furans and DDx appear to be generally collocated in the riverbank soil; therefore, the area of relatively higher furan concentrations will be addressed in tandem with the medium priority DDx area.

ODEQ's 21 July 2009 comments on the draft Riverbank SCSE did not accept the LSS conclusions. ODEQ determined that the entire riverbank was high priority for source control based on:

- Detected concentrations of DDx and CDD/CDFs in riverbank soil in excess of screening levels.
- Presence of bioaccumulative contaminants (PCBs, CDD/CDFs, and DDx) in riverbank soil that have been identified as contributors to potential risk in the adjacent sediment area.
- Elevated concentrations of PCBs, CDD/CDFs, and DDx detected in small mouth bass tissue samples collected adjacent to the Site.
- Bank soils being considered a highly mobile hot spot due to the high contaminant levels observed and the potential for erosion.

LSS disagreed with ODEQ's determination regarding the entire riverbank and notes that ODEQ conclusions were based on data collected before December 2008.

In communications between LSS, Integral, and ODEQ between April and September 2013 (ODEQ 2017, Attachment 3), the parties reached the following agreements:

1. The upland FS for the riverbank will assume that the upper three feet of soil on the riverbank is a high concentration hot spot, except for the areas agreed to in the 3 September 2013 email chain from Matt McClincy to David Livermore titled "Agreements between ODEQ and LSS, July 24, 2013 Meeting".

2. The remedial alternatives will evaluate options to manage terrestrial ecological risk from exposure to riverbank soil, remove concrete and debris, and control erodible soil.
3. During the FS, LSS will collect additional samples just below the top of the bank in the vicinity of sample stations RBC-3 and RBC-5 to verify that there are no hot spots on the riverbank in these areas. A technical memorandum will describe the proposed sampling.
4. ODEQ and LSS will evaluate the need for additional remedial measures in the City of Portland Greenway Overlay Zone where the City directs habitat improvements (e.g., plantings), if appropriate.

ERM summarized source control measure alternatives for managing potential terrestrial ecological risk from exposure to riverbank soil and controlling erodible soil pathway to the Willamette River (ERM 2009b). These riverbank alternatives will be carried into the FS.

Remedial alternatives presented by ERM (2009b) and to be considered in the FS include:

- No action;
- No action with institutional controls;
- Regrading and stabilization;
- Soil removal and stabilization; and
- Combinations of the above, as appropriate.

Stabilization technologies that were presented consisted of, but are not limited to, terraced/vegetated slopes, armoring (e.g., riprap), geocell, and structural walls (e.g., sheet pile).

Riverbank conditions such as slope, surface covering, and contaminant concentrations vary along the approximate 2,000 feet of river frontage at the Site. For the purpose of the remedial alternative evaluation (RAE), the riverbank was divided into three sub-areas based on general physical characteristics and existing data:

- Lots 1 and 2 – This area is characterized by dredge fill spoils with a gradually sloping bank. Invasive vegetation has become established and provides considerable bank stabilization. This area generally contains the lowest constituent concentrations found in the riverbank, with typically decreasing constituent concentrations from the top of bank down to the beach.
- Lot 3 and Salt Pads – This area is characterized by a relatively steep bank with a mixture of debris/riprap and vegetation that provides

substantial stabilization of the steep bank. This area is further comprised of two sections: the riverbank between the Lot 2/Lot 3 boundary and Dock 1, and the riverbank south of Dock 2. It also includes the riverbank along the south boundary of the Site that is owned by Genstar Roofing Co., Inc. Riverbank materials are a mixture of dredge and miscellaneous fill.

- Docks 1 and 2 – This area is characterized by a relatively steep bank with extensive debris/riprap and vegetation that provides substantial stabilization. This area is generally associated with the highest constituent concentrations along the riverbank. Riverbank materials are a mixture of dredge, miscellaneous fill/debris and riprap.

4.0 SUMMARY OF RISK ASSESSMENTS AND HOT SPOT EVALUATIONS

This section presents a summary of the conclusions of the upland HHRA, Level II Screening ERA, and HSEs. The results of the HHRA and the Level II Screening ERA are summarized in Table 4-1.

In order to accurately evaluate the potential risk of exposure of the different human and ecological receptors to COCs, the upland area of the Site was divided into three sections based on the surface conditions and likely future use of the areas: Lots 1 and 2, Lots 3 and 4, and the riverbank. The delineation of these areas is presented on Figure 2-2. The FS will further refine the evaluation of these areas to be fully consistent with the IH zoning on Lots 1, 2, 3, and 4 and with the river-dependent uses currently in place, and to be maintained along the riverbank in accordance with the City of Portland Greenway regulations (City of Portland Code Chapter 33.440).

4.1 HUMAN HEALTH RISK ASSESSMENT

The 2008 *Human Health Risk Assessment* (HHRA) (Integral 2008c) evaluated potential risk to three exposure areas at the Site: Lots 1 and 2, Lots 3 and 4, and the riverbank area. For each exposure area, COCs in soil and groundwater were identified for all potential exposure pathways and possible receptors at the Site.

Several applicable scenarios for human exposure to site soils were defined in the HHRA. These scenarios are based on the following potential receptors at the Site: trespassers, outdoor workers, construction workers, and excavation workers. The potential for exposure of each of these receptors to site soils is dependent on the site conditions and depth as follows: Trespasser (0 to 3 feet bgs), Outdoor Workers (0 to 3 feet bgs), Outdoor Workers after Redevelopment (0 to 15 feet bgs), Construction Workers (0 to 15 feet bgs), and Excavation Workers (0 to 15 feet bgs).

Incremental lifetime cancer risks and noncancer health effects for the COCs were assessed for all relevant exposure pathways and potential receptor combinations. The results of the risk assessment are presented in Table 4-1. The conclusions of the risk assessment are discussed below for each of the three exposure areas evaluated at the Site.

4.1.1 Lots 1 and 2 Soil

For Lots 1 and 2, the results of the Adult Lead Methodology indicated that exposure to lead in soil does not exceed regulatory thresholds for any receptor evaluated. For cancer and noncancer endpoints, the exposure to arsenic and DDT via the incidental ingestion of soil showed potential risks. The total hazard index (HI) for every receptor evaluated for Lots 1 and 2 was less than 1, indicating that adverse health effects are not expected for noncancer endpoints. The total cancer risks for the outdoor worker exposures evaluated at Lots 1 and 2 was 3×10^{-6} for the central tendency exposure (CTE) case and 2×10^{-5} for the reasonable maximum exposure (RME) case. For construction workers, the total cancer risk was 5×10^{-7} and 3×10^{-6} for the CTE and RME cases, respectively. For potential trespassers, the total cancer risk was 2×10^{-6} and 4×10^{-6} for the CTE and RME cases, respectively. The majority of this cancer risk for all receptors is associated with ingestion of arsenic in soil.

~~The source of arsenic at the Site is not related to Site processes and therefore is naturally occurring (i.e., geogenic), has an anthropogenic background, or is from off-site sources. Furthermore, the exposure point concentration (EPC) used in the risk assessment was driven by a single extreme detected concentration.~~

4.1.2 Lots 3 and 4 Soil

For Lots 3 and 4, the lead concentrations in soil were below the screening-levels for soil and were therefore not considered to be a COC for this area. The dominant chemical and exposure route for the cancer and noncancer evaluations was 4,4'-DDT via incidental soil ingestion. For all receptors except the construction worker, the total HI under the CTE case was less than 1, indicating that adverse health effects are not expected for these exposure scenarios. The total HI for the construction worker exposure resulted in a value of 3, indicating that adverse health effects could be associated with this exposure scenario. Under RME conditions, current and future outdoor workers and a construction worker had total HIs greater than 1, with the construction worker value of 8 as the highest, followed by the outdoor worker and outdoor worker under the redevelopment scenario at an HI of 3. These RME results for the worker receptors are slightly above the threshold of 1 and indicate that adverse health effects could occur for the assumed exposures. The highest total incremental lifetime cancer risk of 1×10^{-4} was estimated for an outdoor occupational worker under RME conditions. The CTE cancer risk for this receptor was 2×10^{-5} for the outdoor worker. For the construction worker, the total cancer risks were 3×10^{-6} and 2×10^{-5} for the CTE and RME cases,

respectively. Total cancer risk for the excavation worker was well below 1×10^{-6} under both the CTE and RME conditions.

Total cancer risk for an indoor worker was 2×10^{-6} for the CTE case and 8×10^{-6} for the RME case. These potential risks were driven by a single ~~extreme~~ concentration of tetrachloroethene (PCE) in subsurface soil and are considered an upper-bound estimate of the potential cancer risks. The total HI for the indoor worker was well less than 0.01 for both the CTE and RME case, indicating that potential non-carcinogenic adverse health effects are not expected. The unacceptable risk associated this location will be addressed in the FS.

CDD/CDF detected in catch basins appears to be associated with debris from power pole demolition. ODEQ agrees with this conclusion (see Section 3.3.1). However, ODEQ does not agree that there has been a demonstration yet that Site operations did not also contribute to CDD/CDF concentrations in Site soils and catch basin sediment. Instead of collecting additional surface soil data, ODEQ agreed to move forward provided this assumption was carried into the FS. In accordance with this approach and consistent with detection of other COCs that result in potentially unacceptable risk, the FS will include CDD/CDF in surface soil and present alternatives to manage the potential risks.

4.1.3 Dioxin Soil Lots 1, 2, 3 and 4

The potential for site operations to be a dioxin/furan source was not evaluated until after completion of the site RI and human health risk assessment. As documented in DEQ's October 23, 2008 letter, DEQ determined that catch basin solids data indicate the potential presence of dioxins and furans in sites soil above risk levels. Instead of requiring LSS to collect additional surface soil data DEQ agreed to move forward provided this assumption was carried into the FS. Dioxin/furans have been added to the COC list in surface soil for occupational workers, and the FS will present remedial alternatives to manage this potential risk.

4.1.4 Groundwater

The Human Health Risk Assessment identified chloroform and 1,4-dichlorobenzene as exceeding acceptable risk for indoor occupational workers site wide.

The shallow monitoring well MWA-63 in which chloroform was detected at 9,800 ug/L was constructed after completion of the human health risk assessment. This chloroform concentration exceeds DEQ occupational risk-based concentration for groundwater vapor intrusion into buildings of 1,600 ug/L. Consequently, the vapor intrusion air pathway is added to the list of human health exposure routes and will be addressed by

remedial alternatives developed in the FS for this potential exposure route.

4.1.5 ~~4.1.3~~ Riverbank

For the riverbank area, the blood lead levels predicted for all receptors were below a target level for applicable human receptors, indicating that exposure to lead in soils is not expected to cause adverse health effects. The total HI for all receptors under the CTE exposure was 0.2 or less. For the RME case, the highest total HI was 0.5. Thus adverse health effects are not expected for any of the receptors evaluated for the riverbank. The highest total incremental lifetime cancer risks were predicted for the outdoor worker with values of 3×10^{-6} and 2×10^{-5} for the CTE and RME cases, respectively.

The total cancer risk for the construction worker was 5×10^{-7} for the CTE case and 3×10^{-6} for the RME case. For the trespasser exposures, the total cancer risk was 2×10^{-6} for the CTE case and 4×10^{-6} for the RME case. The cancer risks for all receptors were dominated by the incidental ingestion of CDD/CDF and arsenic in soils.

Total cancer risk for an indoor worker was 2×10^{-6} for the CTE case and 8×10^{-6} for the RME case. These potential risks were driven by a single **extreme** concentration of PCE in subsurface soil and are considered an upper-bound estimate of the potential cancer risks. The total HI for the indoor worker was well less than 0.01 for both the CTE and RME case, indicating that potential **non-carcinogenic** adverse health effects are not expected. The unacceptable risk associated this location will be addressed in the FS.

The HHRA identified the following additional compounds as exceeding the Oregon Risk-Based Decision-Making (RBDM) carcinogenic screening criteria for one or more potential human health exposure pathways, but did not present an unacceptable risk: chromium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, 4,4'-DDD, 4,4'-DDE, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene. The specific compounds that exceeded the RBDM SLVs for individual exposure pathways are summarized in Table 4-1. Per ODEQ directives, these compounds are included in the HSE (Section 4.3). The FS will consider chemicals identified in the approved HHRA.

4.2 LEVEL 2 SCREENING LEVEL ECOLOGICAL ASSESSMENT

Potential ecological habitat exists in previously developed and disturbed areas along portions of the riverbank and within limited portions of Lots 1 and 2. Lots 3 and 4 are generally covered by impervious or uninhabitable

surfaces including pavement, gravel, and building foundations that preclude establishment of any meaningful ecological habitat and were, therefore, excluded from the evaluation. The portion of the riverbank that extends from the top of bank down to the mean-high-water line of the Willamette River is steeply sloping and covered with rubble used for bank stabilization; a limited amount of vegetation has colonized the area and grows among the bank-armoring material. Riverbank vegetation is characterized by ruderal species or those species likely to first colonize an idle industrial area, including Scotch broom, Himalayan blackberry, black mustard, and curly dock.

4.2.1 Receptors

Four categories of ecological receptors were evaluated in the Level II Screening ERA: plants, invertebrates, birds, and mammals (Integral 2009a). Three COCs (chromium, lead, and DDX) where identified by LSS as exceeding the conservative generic SLVs for at least one ecological receptor. DEQ modified the Level II screening in a March 15, 2010 letter and added alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane, DDD, DDE, DDT, TCDD TEQ, BEHP, dibutyl phthalate, As, Cu and Zn. The specific COCs for each receptor are summarized in Table 4-1. The SLVs, which are not risk based for chromium, for plants and invertebrates are below the regional background concentration. Therefore, concentrations of chromium in soil that exceed the regional background concentration (76 mg/kg) were used to define areas of the Site that potentially result in an unacceptable risk to these ecological receptors.

As stated above, the current and reasonably likely future land use in the LOF is defined and the Site is located in the heart of the Guild's Lake Industrial Sanctuary, which is zoned and designated by the City of Portland as "IH" for heavy industrial use. The FS will further refine the evaluation of the areas of potential ecological exposure to be fully consistent with 1) the IH zoning on Lots 1, 2, 3, and 4; 2) the Site conditions following implementation of the SCMs; and 3) the river dependent uses required to be maintained along the riverbank in accordance with the City of Portland Greenway regulations (City of Portland Code Chapter 33.440).

4.2.2 Lots 1 and 2

Lots 1 and 2 were formerly developed to receive process-related materials and store spare pieces of equipment and graded dredged spoils; currently, Lots 1 and 2 are idle industrial areas that have been colonized in localized areas by a mixture of native and invasive plant species. On the northeastern edge of Lot 1 is a stand of black cottonwood trees, a willow thicket, and an area with scrub-shrub vegetation that has been designated

as medium- to high- relative rank (City of Portland 2008). Trees and scrub-shrub vegetation also exist on the western end of Lot 1. The remainder of the property is vegetated with grass or is bare/covered with aggregate material.

The potential ecological habitat evaluated during the Level II Screening ERA was limited to Lot 1 and the northeastern portion of Lot 2, and the riverbank between the top of the bank and ordinary low water. Portions of the passively colonized vegetation on the upland parts of Lot 1 and 2 have been altered or removed by maintenance (surface grading, gravel placement, and construction of the stormwater SCM) conducted during implementation of the Stormwater and Groundwater SCMs, and this condition is not reflected in the Level II Screening ERA. Maintenance activities have returned lots 1 and 2 to their industrial-use conditions. Therefore, the FS will consider lots 1 and 2 under an appropriate industrial use scenario.

4.2.3 Riverbank

Based on the above assessments and ongoing actions at the Site, the FS will evaluate portions of the riverbank for use as a potential future ecological habitat (i.e., between the top of bank and ordinary low water) in those areas of the riverbank not intended and/or needed currently and in the future to maintain the river dependent use of the Site.

In communications between LSS, Integral, and ODEQ between April and September 2013 (ODEQ 2017, Attachment 3), in lieu of additional sampling, the parties reached agreements on the nature of conditions on the riverbank and how presumed conditions would be evaluated in the FS. Section 3.6.3 provides additional details.

ERM summarized source control measure alternatives for managing potential terrestrial ecological risk from exposure to riverbank soil and controlling erodible soil pathway to the Willamette River (ERM 2009b). These riverbank alternatives will be carried into the FS.

4.3 SUMMARY OF HOT SPOT EVALUATION

Oregon Revised Statute [ORS 465.315] Environmental Cleanup Rules [OAR 340-122] require identification of hot spots as part of the Remedial Investigation and Feasibility Study and treatment of hot spots, to the extent feasible. ODEQ (1998a) provides guidance for identification of hot spots.

LSS has prepared three previous hot spots evaluation reports (ERM 2006c, ERM 2012a, ERM 2013). This Work Plan updates the hot spots evaluations in response to ODEQ's 28 June 2012 comments on the *Hot Spot Evaluation Update* (ERM 2012a) and ODEQ's 3 April 2017 comment letter on the hot spot evaluation in the July 2013 draft Work Plan.

~~Appendix A of this Work Plan is the revised HSE. Tables 4-2 list receptors, exposure pathways, and basis for hot spot criteria. Tables 4-3 through 4-5 list screening values and selected hot spot criteria. Appendix A includes hot spot screening tables, figures, and summary text. The Preliminary Hot Spot has been separated from this Work Plan. Summary Tables 4-2 Hot Spot Receptor Pathway Evaluation; Table 4-3 Direct Exposure Pathway Based Screening Criteria; Table 4-4 Indirect Exposure Pathway Based Screening Criteria; and Table 4-5 Indirect Exposure Pathway Based Screening Criteria are to be revised and submitted as part of a revised Preliminary Hot Spot Evaluation.~~

The purpose of presenting the hot spot screening tables and figures is to identify hot spots of the Site that will be carried forward into the FS for evaluation of potential remedial actions (OAR 340-122-090). As requested by ODEQ in an email dated 20 February 2013, the updated HSE includes iso-concentration maps of COCs in soil and groundwater to support the FS. Appendix A Figures A-1 through A-114 show screening level exceedances and hot spots in soil and groundwater.

5.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

This section describes the process that will be used for developing remedial action alternatives. This process includes the identification of RAOs and general response actions, identification and screening of remedial technologies, and assembly of remedial action alternatives. This process follows the ODEQ *Guidance for Conducting Feasibility Studies* (ODEQ 2006).

5.1 APPLICABLE AND RELEVANT OR APPROPRIATE REQUIREMENTS

A preliminary list of statutes and regulations that may be considered ARARs for the project is included in Table 5-1. These and other potential ARARs can be generally categorized as chemical-specific, action-specific, or location-specific.

The list of ARARs in Table 5-1 includes rules and regulations typically relevant for in-water actions. These have been included for completeness and to ensure consistency with the Portland Harbor Record of Decision.

5.2 IMPACTED MEDIA

Media of potential concern on the upland portion of the Site pertinent to the FS include soil, groundwater, and stormwater. The FS will use existing RI data, Supplemental RI data, EE/CA data, Stormwater SCM and Groundwater SCM performance monitoring data, ~~and any data developed prior to completion of the FS to assess these media and potential remedial actions.~~

Soil and groundwater at the Site have been impacted with VOCs, SVOCs, metals, pesticides, dioxins, and furans. ~~The Site does not appear to be a source of dioxins, and the dioxin is assumed to originate from power pole sawdust near and in the catch basins, background, and off-site sources.~~ The FS will utilize results from the approved the HHRA and Level II Screening ERA, and the areas and volumes identified in the preliminary hot spots evaluation.

~~The FS will use the ODEQ's conservative approach to develop hot spots assess the volume of contaminated media. In addition, to assess risk reduction and cost associated with levels of risk reduction (a risk range and range of approaches), the FS will evaluate areas which may require remediation based upon risk levels developed in HHRA and the Level II Screening ERA values (or alternatively Site Specific Ecological Risk-Based levels) to assess the volumes of contaminated media to provide a~~

~~more scientifically defensible approach based upon a range of risks versus the HSE alone. In addition, during remedial design, LSS will refine methods to assess leaching to groundwater and develop site-specific remedial action levels⁴ for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre-design sampling will be incorporated into the remedial design/remedial action (RD/RA).~~

5.2.1 Identification of Areas or Volumes of Media ~~Which May~~ Potentially Require Remedial Action

The FS will examine areas at the Site containing media that exceed the acceptable risk levels and areas or volumes identified as hot spots of contamination presented in this FS Work Plan. ~~Some of the areas identified as preliminary hot spots (Appendix A) are based on generic screening levels. As discussed in the previous section, these preliminary hot spot areas will be further refined in the FS as site-specific remedial action levels are established. The development of site-specific remedial action levels is described in Section 5.3.~~

~~The area and volume of impacted media that may require remedial action in the treatment approach alternative development will be calculated in the FS as the remedial actions levels are finalized. As required in the Consent Order, a preliminary estimate of volume exceeding Preliminary Numerical RAOs identified in this work plan will be calculated for each affected environmental medium. The results of the volume calculation for soil and groundwater will be presented in the Preliminary Hot Spot Evaluation.~~

5.2.2 Estimate of Preliminary Hot Spot Volumes

As required in the Consent Order, a preliminary estimate of the volume of hot spot material ~~was~~ will be calculated for applicable exposure scenarios and contaminants in soil, groundwater, and DNAPL. The results of the volume calculations for soil and groundwater will be presented in the Preliminary Hot Spot Evaluation. These estimated volumes will be used in the FS in the alternatives evaluation. ~~are presented in Tables 5-2 and 5-3, respectively.~~

⁴As used in this document, the term “action level” means a concentration at a specific monitoring point other than the point of exposure that is indicative of a protective concentration at the point of exposure.

5.2.3 Refinement of Remediation Areas and Volumes.

~~In addition, during remedial design, LSS will refine methods to assess leaching to groundwater and develop site-specific remedial action levels⁴ for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre-design sampling will be incorporated into the remedial design / remedial action (RD/RA).~~

Estimates of hot spot volumes developed in the FS and used to compare alternatives will be based on conservative assumptions, as required by the ODEQ. During remedial design, LSS may propose methods to assess leaching to groundwater and develop site-specific remedial action levels for both the groundwater and the leaching to groundwater pathway. A technical memorandum will describe proposed sampling and analysis to refine soil action levels and remediation volumes in the design. Additional pre-design sampling will be incorporated into the remedial design / remedial action (RD/RA).

~~These areas and volumes may be refined in the remedial design based on Site-specific groundwater and leaching to groundwater and ecological action levels and contemporary datasets and site conditions. For example, passively colonized vegetation on the upland parts of Lot 1 and 2 have been altered or removed by maintenance (surface grading, gravel placement, and construction of the stormwater SCM) conducted during the implementation of the Stormwater and Groundwater SCMs, and this condition was not reflected in the Level II Screening ERA. Maintenance activities have returned Lots 1 and 2 to their industrial use conditions. Therefore, the FS will consider Lots 1 and 2 under an appropriate industrial use scenario.~~

~~LSS will work with the ODEQ to assess empirical (sampling) or theoretical (calculations, modeling, and statistics) methods to compare chemical concentrations in the transition zone to concentrations in upland groundwater by area of the Site (e.g., Lots 1, 2 vs Lots 3, 4). A statistically-based sampling and analysis or a theoretical analysis may be incorporated into the remedial design to develop risk-based action levels. Alternative leaching to groundwater models, such as Summers and/or PESTAN, may be used to develop site-specific remedial action levels for both the groundwater and the leaching to groundwater pathways.~~

~~A separate technical memorandum will describe the sampling and analysis methods. The remedial design will use the data and analysis to develop upland soil and groundwater action levels and refine estimates of areas and volumes in the FS. Additional pre-design sampling may be~~

~~incorporated into the RD/RA.~~

5.3 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES

RAOs are media-specific goals for protecting human health and the environment. The RAO process considers primary criteria to:

1. Develop and identify impacted media with the specific goal of achieving the standards for protectiveness as specified in OAR 340-122-0040(2). These standards are the acceptable risk levels defined in OAR 340-122-0115.
2. Treat or remove hot spots of contamination based on feasible remedy selection balancing factors.

The RAOs for the upland FS process must be consistent with the in-water remedial objectives established by EPA under the Portland Harbor Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI/FS process.

Following are Site-specific ROAs:

- RAO 1- Reduce upland human health risks to acceptable risk-based levels from incidental ingestion, inhalation, and direct contact with soil under trespasser, outdoor worker, outdoor worker after redevelopment, and construction worker scenarios.
- RAO 2 - Reduce riverbank terrestrial ecological risks to acceptable risk-based levels from ingestion and direct contact with soil.
- RAO 3 - Prevent or reduce the potential for migration of COCs in surface soil and riverbank soil to accumulate in Willamette River sediment above acceptable risk-based levels.
- RAO 4 - Treat or remove soil hot spots to the extent ~~technically-practicable or~~ feasible based on remedy selection balancing factors.
- RAO 5 - Prevent or reduce the migration of groundwater COCs to the Willamette River above acceptable risk-based levels for surface water receptors.
- RAO 6 - Treat or remove groundwater hot spots to the extent ~~technically-practicable or~~ feasible based on remedy selection balancing factors.
- RAO 7 - Reduce the potential for DNAPL to act as a continuing source for COCs in groundwater.
- RAO 8 - Treat or remove DNAPL hot spots to the extent ~~technically-practicable~~ or feasible based on remedy selection balancing factors.

~~The performance of these RAOs will be assessed against applicable~~

~~remedial action levels established during the FS process. Preliminary numerical RAOs (i.e., remedial action levels) are discussed below.~~

The following RAOs were established for the Stormwater SCM and are applicable to stormwater in the Site-wide FS process.

- RAO 9 - Reduce the migration of COCs in stormwater to the Willamette River that are at or above acceptable RBCs for surface water receptors.
- RAO 10 - Reduce the migration of COCs in stormwater to the Willamette River to prevent accumulation of COCs in river sediment above risk-based levels.

5.3.1 Preliminary Numerical Remedial Action Objectives

The results of HHRA and ERAs are generally used to help identify medium-specific and chemical-specific numerical RAOs for a site. The type of numerical RAO that is chosen for each chemical will depend, to some extent, on the type of risk assessment that is (or was) conducted (i.e., screening-level assessments versus baseline assessments). Screening-level risk assessments typically compare maximum detected concentrations of chemicals detected in Site media to conservative risk-based protective screening criteria.

RAO 1

The preliminary numerical RAOs established for direct exposure to soil for human health exposure pathways and applicable COCs, will be used to evaluate remedial alternatives to achieve RAO 1 are summarized in Table 5-4.

~~The FS will use the Preliminary Numerical RAOs are the risk values from either the ODEQ approved upland HHRA or the ODEQ RBDM Table 11 to identify numerical RAOs. Areas and volumes in the FS will reflect the RAOs. Areas and volumes in the FS will be based on these Preliminary Numeric Remedial Action Objectives. In addition, for the purpose of evaluating alternatives for acceptable residual risk to human receptors, LSS intends to apply a target risk range of 1×10^{-4} to 1×10^{-6} in accordance with CERCLA and consistent with the Portland Harbor HHRA (Kennedy/Jenks Consultants 2013). The COPCs identified in the HHRA that exceeded these is target risk range concentrations are summarized in Table 4-1. Preliminary numerical RAOs for the target range of acceptable risk to human receptors are presented in Table 5-4. During remedial design, the areas and volumes of media requiring remediation will be refined via empirical (sampling) or theoretical (calculations, modeling, and statistics) methods to develop remedial action levels (i.e., numerical RAOs).~~

RAO 2

The preliminary numerical RAOs established for direct exposure to soil for ecological exposure pathways and contaminants of interest are the Screening Benchmark Values used in the ecological risk assessment and are summarized in Table 5-5.

The preliminary numerical RAOs presented in Table 5-4~~5~~ will be used for screening the residual COCs in soil to evaluate the alternatives for acceptable residual risk to ecological receptors and to evaluate residual risk. ~~As noted above, the preliminary numerical RAOs are inherently conservative. If necessary, LSS will prepare a quantitative ERA in accordance with OAR 340-122-0084 to evaluate any residual risk to ecological populations within the locality of the facility for the proposed remedial alternatives. LSS notes that, per the *Guidance for Ecological Risk Assessment: Levels I, II, III, IV* (ODEQ 1998b), a Level III baseline risk assessment for the Site may need to be completed prior to the preparation of the residual risk assessment.~~

RAO 3

The Preliminary Numerical RAOs established for soil erosion to Willamette River are the Portland Harbor RAO 9 Cleanup Levels, or if not available the Joint Source Control SLVs used in the December 2008 Riverbank Erodible Soil Source Control Evaluation. Table 5-7 presents the Numerical RAOs for contaminants identified as exceeding JSCS SLVs in the Riverbank Erodible Soil Source Control Evaluation. The Preliminary Numeric RAOs presented in Table 5-7 will be used to evaluate remedial alternatives to achieve RAO 3.

RAO 4

The Preliminary Numerical RAOs for hot spots established for direct exposure to soil for human health exposure and ecological receptor pathways are summarized in Tables 5-4 and 5-5. The hot spot criteria presented in Table 5-4 are based on the risk values from either the ODEQ approved upland HHRA or the ODEQ RBDM Table 11. The hot spot criteria presented in Table 5-5 are based on ODEQ Ecological Risk Screening Benchmark Values. These hot spot criteria will be used in the Preliminary Hot Spot Evaluation and in the FS to evaluate remedial alternatives to achieve RAO 4.

RAO 5

The Preliminary Numeric RAOs established for groundwater migration to the Willamette River are protective of the DEQ identified beneficial use of groundwater; recharge to aquatic habitat, as well as EPA's Portland Harbor determined use for surface water as a drinking water source. Groundwater Preliminary Numeric RAOs are based on the lowest

applicable Ambient Water Quality Criteria (AWQC). If aquatic life AWQC are not available the lower of the DEQ Table 33C (currently Table 31) or ORNL values are used. Preliminary Numeric RAOs for groundwater are presented in Table 5-6.

Note that the Preliminary Numeric RAOs for RAO 5 are different from the groundwater Hot Spot Criteria in that they are based on the AWQC for “**human health for the consumption of water and Organism**”. This difference results from EPA’s source control decision which determined the Willamette River is a potential drinking water source. DEQ Cleanup Program does not consider the Willamette River a potential drinking water source so this pathway was not carried into the Preliminary Hot Spot Evaluation.

The preliminary numerical RAOs established for indirect exposure to groundwater and soil for ecological exposure pathways and applicable COCs are presented in Table 5-6.

RAO 6

The Preliminary Numeric RAOs established for groundwater discharging to the Willamette River hot spots are protective of the DEQ identified beneficial use of groundwater. Groundwater Preliminary Numeric RAOs are based on the lowest applicable Ambient Water Quality Criteria (AWQC). If aquatic life AWQC are not available the lower of the DEQ Table 33C (currently Table 31) or ORNL values are used. Soil Preliminary Numeric RAOs are based on the groundwater values and an equilibration calculation with a generic dilution and attenuation factor. Preliminary Numeric RAOs for groundwater are the hot spot criteria presented in Table 4-4. Preliminary Numeric RAOs for soil will be presented in the Preliminary Hot Spot Evaluation.

Note that the Preliminary Numeric RAOs for RAO 6 are Hot Spot Criteria and are different then the Preliminary Numeric RAOs for RAO 5, in that they are based on the AWQC for “**human health for the consumption of Organism Only**”. This difference results from EPA’s source control decision, which determined the Willamette River is a potential drinking water source. DEQ Cleanup Program does not consider the Willamette River a potential drinking water source so this pathway was not carried into the Preliminary Hot Spot Evaluation.

RAO 7 and 8

Preliminary Numerical RAOs are not applicable to RAO 7 and 8.

As discussed previously in Sections 4.3.2 and 4.3.3, LSS intends to development Site specific remedial action levels for groundwater and soil leaching to groundwater pathways. These remedial action levels will be used to evaluate the performance of remedial actions at achieving the

RAOs.

RAO 9 and 10

~~There are currently no Site-specific numerical RAOs for the Stormwater SCM. Stormwater treatment alternatives will be developed to meet the effluent goals and the stormwater RAOs to the extent technically possible in considering the balancing factors of the FS. The Preliminary Numerical RAOs established for stormwater discharge to the Willamette River are the Portland Harbor RAO 9 Cleanup Levels for surface water. Table 5-8 presents the Preliminary Numerical RAOs for contaminants identified in Attachment A of the Stormwater Source Control Measure Mutual Agreement and Order (No. WQ/1-NWR-10-175). The Preliminary Numerical RAOs presented in Table 5-8 will be used to evaluate remedial alternatives to achieve RAO 9 and 10.~~

5.4 IDENTIFICATION OF GENERAL RESPONSE ACTIONS

The general response actions will consider and satisfy the RAOs developed for the Site. These actions will target specific areas and volumes for each impacted media and any identified hot spots. General response actions will be based on several factors, including exposure routes, nature and extent of the contamination, RBCs, and action-specific applicable or relevant and appropriate requirements (ARARs) as applied to applicable media.

The FS will use existing data and historical Site information to identify Site conditions that may limit or promote specific response actions ~~and any new data gathered as part of or in advance of completing the FS~~. The FS will also develop a range of alternatives based on these general response actions:

- No Action
- Engineering and/or Institutional Controls (i.e., containment)
- Treatment
- Excavation and Off-Site Disposal
- Any combination of the above, as appropriate

Oregon environmental cleanup law allows the elimination of one or more general response actions from development if the Department determines the proposed remedial action alternative(s) is not clearly protective, feasible, or otherwise appropriate for the facility, as specified in OAR 340-122-0085 (3).

Justification for the proposed elimination should consider factors pertinent to the ODEQ remedy selection criteria.

5.5 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Under this task in the FS, potential containment, treatment, and removal technologies applicable to each general response action will be identified. It will also eliminate (screen) any technologies that are inappropriate for the Site based on effectiveness, implementability or cost.

5.6 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The development of several remedial action alternatives will be presented in the FS. Their evaluation will consider the performance and impact of the previous IRMs and the current Groundwater SCM, which includes dissolved-phase contaminant recovery, and the Stormwater SCM, which includes capping of soil. The assembled alternatives ~~may~~will include additional technology considerations to remove or treat hot spots soils, enhance DNAPL treatment or removal, and impacted groundwater cleanup necessary to meet the Site-specific RAOs.

The range of technologies currently being considered includes, but is not limited to, the following:

- Soil – in situ and ex situ treatment and/or stabilization, capping, monitored natural attenuation and removal, including on-site management and off-site disposal.
- Groundwater – hydraulic containment and ex situ treatment (currently being implemented), in situ treatment, in situ stabilization/fixation, hydraulic isolation, in-river capping and monitored natural attenuation.
- Stormwater – alternatives will include the existing interim system, a Site-wide cap that eliminates stormwater contact with contaminated soils, and associated institutional controls.

Alternative remedial actions for the riverbank were previously presented to the ODEQ in the *Summary of Remedial Alternatives, Riverbank Source Control Measure* (ERM 2009b). An alternatives evaluation for the RAA Riverbank area (ERM 2012c) was submitted to EPA as an Appendix to the EE/CA report (Integral 2012). Based on communication with the ODEQ (Matt McClincy e-mail to Todd Slater, dated 13 May 2013), LSS anticipates that alternative remedial actions for the riverbank will be similar to those already presented to the ODEQ.

Similar to the approach followed for the Groundwater SCM FFS process, LSS will submit an assembly of remedial action alternatives for the Site-wide remedy to the ODEQ for review prior to conducting the evaluation of the remedial alternatives. This will enable agreement on the combination of technologies in each remedial alternative that will be

evaluated in the FS.

6.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The alternative evaluation process includes both an individual and comparative evaluation of remedial action alternatives. The individual evaluation measures each remedial alternative against the protectiveness requirement, a balancing of remedy selection factors, and the preference to treat or remove hot spots of contamination. The Preliminary Numeric RAOs developed during the FS identified in the FS Work Plan are used as quantitative indicators of protectiveness and hot spot treatment levels.

Each remedial alternative is evaluated both individually and compared to other alternatives to evaluate which alternative or alternatives best satisfy specific evaluation criteria. The purpose of the individual assessment is to evaluate the extent to which each remedial action alternative satisfies the selection criteria. The comparative assessment provides a relative evaluation of the remedial action alternatives to determine which alternative best balances the selection factors and provides the best comprehensive remedial approach.

Remedial alternatives will be evaluated and compared to identify a preferred alternative. This section describes the evaluation of remedial alternatives, including:

- Description of evaluation criteria;
- Evaluation of each alternative;
- Comparison of alternatives; and
- A description of the preferred alternative.

6.1 PROTECTIVENESS REQUIREMENT

Oregon law requires that each remedy achieve the standards for “protectiveness” (i.e., that it protects human health and the environment) demonstrated through a residual risk assessment as specified in OAR 340-122-0040(2). This risk assessment precedes the selection or approval of the remedial action as specified in OAR 340-122-0084(4).

ODEQ guidance for the residual risk assessment (ODEQ 2006) includes:

- (a) A quantitative assessment of the risk resulting from concentrations of untreated waste or treatment residuals remaining at the facility at the conclusion of any treatment or excavation and off-site disposal activities, taking into consideration current and reasonably likely future land and water use scenarios and the exposure assumptions used in the baseline risk assessment.

- (b) A qualitative or quantitative assessment of the adequacy and reliability of any institutional or engineering controls to be used for management of treatment residuals and untreated hazardous substances remaining at the facility.
- (c) The combination of (a) and (b) constitute a residual risk assessment that must demonstrate to the ODEQ that acceptable levels of risk as defined in OAR 340-122-0115 would be attained in the locality of the facility.

6.2 *REMEDY SELECTION FACTORS*

Each remedial action alternative assessment will be based on a balancing of the five remedy selection factors and the ability to treat or remove hot spots of contamination. These factors include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. The following sections provide general information about the remedy selection factors and related criteria. The criteria will be used for the evaluation of each alternative in accordance with OAR 340-122-0090(3) and (4).

6.2.1 *Effectiveness*

Effectiveness assesses the remedial action alternative and its ability to achieve the desired level of protection or restore any significant adverse effects on beneficial uses of media as quickly as possible.

The effectiveness criterion assists in determining the ability of the remedial action alternative to meet the required level of protection of human health and the environment. The effectiveness criterion evaluates the performance of the alternative through implementation of the remedial action and achievement of RAOs. Additional long-term effectiveness of the alternative is evaluated under the long-term reliability criterion (Section 6.2.2). The effectiveness of an alternative is both a qualitative (e.g., adequacy of engineering and institutional controls) and a quantitative (e.g., magnitude of potential risk from treatment residuals) analysis.

The effectiveness criteria that are used, as appropriate, for assessment of remedial alternatives include the following:

- (A) Magnitude of risk from untreated waste or treatment residuals remaining at the facility absent any risk reduction achieved through on-site management of exposure pathways, as determined in Guidance for Conducting Feasibility Studies Updated 8-12-2008 DEQ-08-LQ-088 Page 20 OAR 340-122-0084(4)(a). The characteristics of the residuals shall be considered to the degree

that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade.

- (B) Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the facility, as determined in OAR 340-122-0084(4)(b).
- (C) With respect to hot spots of contamination in water, the extent to which the remedial action restores or protects existing and reasonably likely future beneficial uses of water.
- (D) Adequacy of treatment technologies in meeting treatment objectives.
- (E) Time until the remedial action objectives would be achieved.
- (F) Any other information relevant to effectiveness.

6.2.2 Long-Term Reliability

Long-term reliability assesses the remedial action alternative and its ability to maintain the required level of protection over a specific time period.

The long-term reliability criterion provides an evaluation of an alternative's ability to provide an adequate level of protection over the long term after implementation. Long-term reliability focuses on the magnitude of residual risk after RAOs are achieved. This criterion also evaluates the adequacy and reliability of engineering or institutional controls. Long-term reliability is generally a qualitative evaluation.

Evaluation of remedial alternatives shall consider the following, as appropriate:

- (G) Reliability of treatment technologies in meeting treatment objectives.
- (H) Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, taking into consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure.

- (I) Nature, degree, and certainties or uncertainties of any necessary long-term management (e.g., operation, maintenance, and monitoring).
- (J) Any other information relevant to long-term reliability.

6.2.3 Implementability

This assessment determines whether, or with how much difficulty, the remedial action alternative can be implemented and the extent and verification of its effectiveness over time.

The implementability criterion provides an assessment of remedial alternatives during the construction and implementation phases through the stage where the remedial objectives are met. Implementability considerations include technical and administrative feasibility, as well as availability of services and materials, and generally comprise a qualitative analysis. Technical feasibility considerations include construction, operation, and reliability of a technology, as well as monitoring considerations. Administrative considerations can include coordination with multiple offices or agencies.

The ease or difficulty of implementing a remedial alternative is evaluated by considering the following, as appropriate:

- (K) Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays.
- (L) The ability to monitor the effectiveness of the remedy.
- (M) Consistency with federal, state and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies.
- (N) Availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-site treatment, storage, and disposal capacity and services, and availability of prospective technologies.
- (O) Any other information relevant to implementability.

6.2.4 Implementation Risk

This criterion considers how the alternative affects the construction and implementation phase (i.e., up to the point that RAOs are met). This risk evaluation measures the alternatives with respect to their effect on human health and the environment during implementation of the remedial action. Implementation risk is also referred to as short-term risk.

Implementation risk is generally a qualitative analysis of the risks or impacts to human health and the environment that may occur due to the implementation of a remedial measure. The risk associated with implementing a remedial alternative shall be evaluated based on the following criteria, as appropriate:

- (A) Potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures.
- (B) Potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures.
- (C) Potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures.
- (D) Time until the remedial action is complete.
- (E) Any other information related to implementation risk.

6.2.5 Reasonableness of Cost

Each remedial action alternative shall be assessed for the reasonableness of cost, by considering all of the following criteria, as appropriate:

- (A) Cost of the remedial action including:
 - (i) Capital costs, including both direct and indirect costs
 - (ii) Annual operation and maintenance costs
 - (iii) Costs of any periodic review requirements
 - (iv) Net present value of all of the above.
- (B) Degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management.

- (C) With respect to hot spots of contamination in water, the degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water.
- (D) Degree of sensitivity and uncertainty of the costs.
- (E) Any other information relevant to cost-reasonableness.

The reasonableness of cost is a two-part assessment. First, the cost of each remedial action alternative is estimated using standard engineering procedures. These estimated costs will be prepared to a +50 to -30 percent (of actual cost for alternative implementation) accuracy typical of FS-level cost estimates. The cost estimates will be prepared with detail to clearly indicate the assumptions made to prepare each estimate. They will also include percentages for unlisted items/contingencies.

Second, reasonableness determines the degree to which the costs are proportionate to the benefits of the remedy. This assessment qualitatively compares the remedial actions to each other. The alternatives that are more protective, can be readily implemented with minimal impacts to the community, workers, and the environment, and have a lower cost will be regarded as having a greater level of protection.

6.3 PREFERENCE FOR TREATMENT OR EXCAVATION OF HOT SPOTS

Oregon environmental cleanup law requires that all remedies treat or remove hot spots of contamination to the extent feasible. The evaluation of feasibility is based on the five remedy selection factors. A higher threshold is applied to the reasonableness of the cost for managing hot spots.

The FS will evaluate the feasibility of treatment for groundwater hot spots to levels that no longer produce significant adverse effects (OAR 340-122-0115[5]) to the beneficial use of groundwater.

6.4 ANALYSIS OF ALTERNATIVES

6.4.1 Detailed Analysis of Alternatives

The FS will conduct an individual evaluation to determine how well each remedial action alternative satisfies the remedy selection criteria, including whether the RAOs will be achieved. This section of the FS will be organized by alternative and will include a detailed description of the alternative by media and location, followed by an evaluation against each

criterion (protectiveness, remedy selection factors, and the extent of hot spot remediation).

6.4.2 *Comparative Analysis of Alternatives*

The FS will include a comparative analysis of all alternatives. Following the individual evaluation of the alternatives, the alternatives will be compared to each other. The comparative evaluation will provide a relative evaluation to identify and recommend the alternative that best satisfies the criteria. This section of the FS will include a narrative discussion describing the strengths and weaknesses of the individual alternatives relative to one another. The comparative evaluation of alternatives will also include a quantitative table in addition to text.

~~Subject to the preference for treatment of hot spots, the least expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors. The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management.~~

6.4.3 *Recommended Remedial Action Alternative*

This section of the FS will recommend a remedial action alternative based on the individual and comparative analyses. The recommended alternative must meet all of the remedy selection criteria as discussed in Section 6.2. The FS will recommend a remedial action that is:

- (a) Protective of present and future public health, safety and welfare and of the environment, as specified in OAR 340-122-0040;
- (b) Based on a balancing of remedy selection factors, as specified in OAR 340-122- 0090(3); and
- (c) Satisfies the requirements for hot spots of contamination, as specified in OAR 340- 122-0090(4).

All remedies must be protective of present and future public health, safety and welfare and of the environment. The remedies selected must also align with the RAOs identified for the Portland Harbor Record of Decision. ~~In general, the recommended alternative should be the least expensive protective alternative, unless the additional cost for a more expensive alternative is justified by proportionately greater benefits within one of the remedy selection factors and significant decrease in residual risk. Subject to the preference for treatment of hot spots, the least~~

expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors. The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management.

7.0 REPORTING

A series of interim reporting steps are proposed as part of the FS process. These interim deliverables are intended to provide a framework for LSS to present key assumptions and ODEQ the opportunity to comment on and approve these assumptions prior to incorporation into the FS.

- **Alternatives Scoping Technical Memorandum** – This will present the technologies for consideration in the FS. Combination of technologies, media, and areas of the Site will be presented as specific alternatives to be evaluated in the FS.
- **Site-Specific Action Level Development Summary** – LSS will screen for hot spots using the AWQC and assuming that constituents in groundwater are transported unattenuated to the transition zone. LSS does not agree that the same assumptions are appropriate for determining action levels to be developed in remedial design. The groundwater action levels must accommodate new data and analysis that may demonstrate attenuation from concentrations in groundwater to the transition zone.
- **Feasibility Study Report** – The FS report will discuss the FS results as described in this Work Plan and meet the requirements of the Scope of Work detailed in the Consent Order.

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Figures



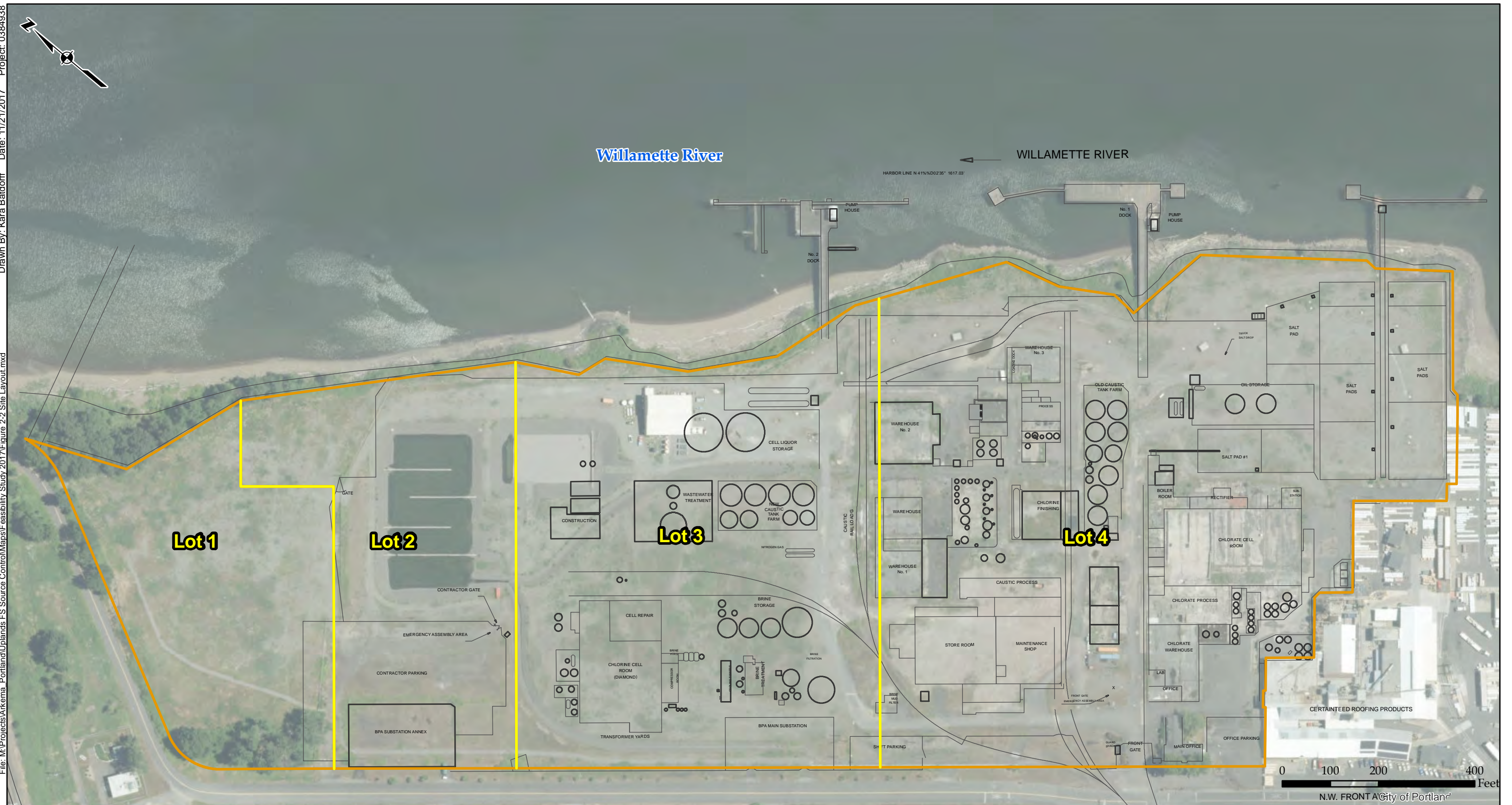
Legend

-  Parcel and Property Boundaries



0 1 2 4 Miles

Figure 2-1
Site Location
 Revised Feasibility Study Work Plan
 Arkema Inc.
 Portland, Oregon



Legend

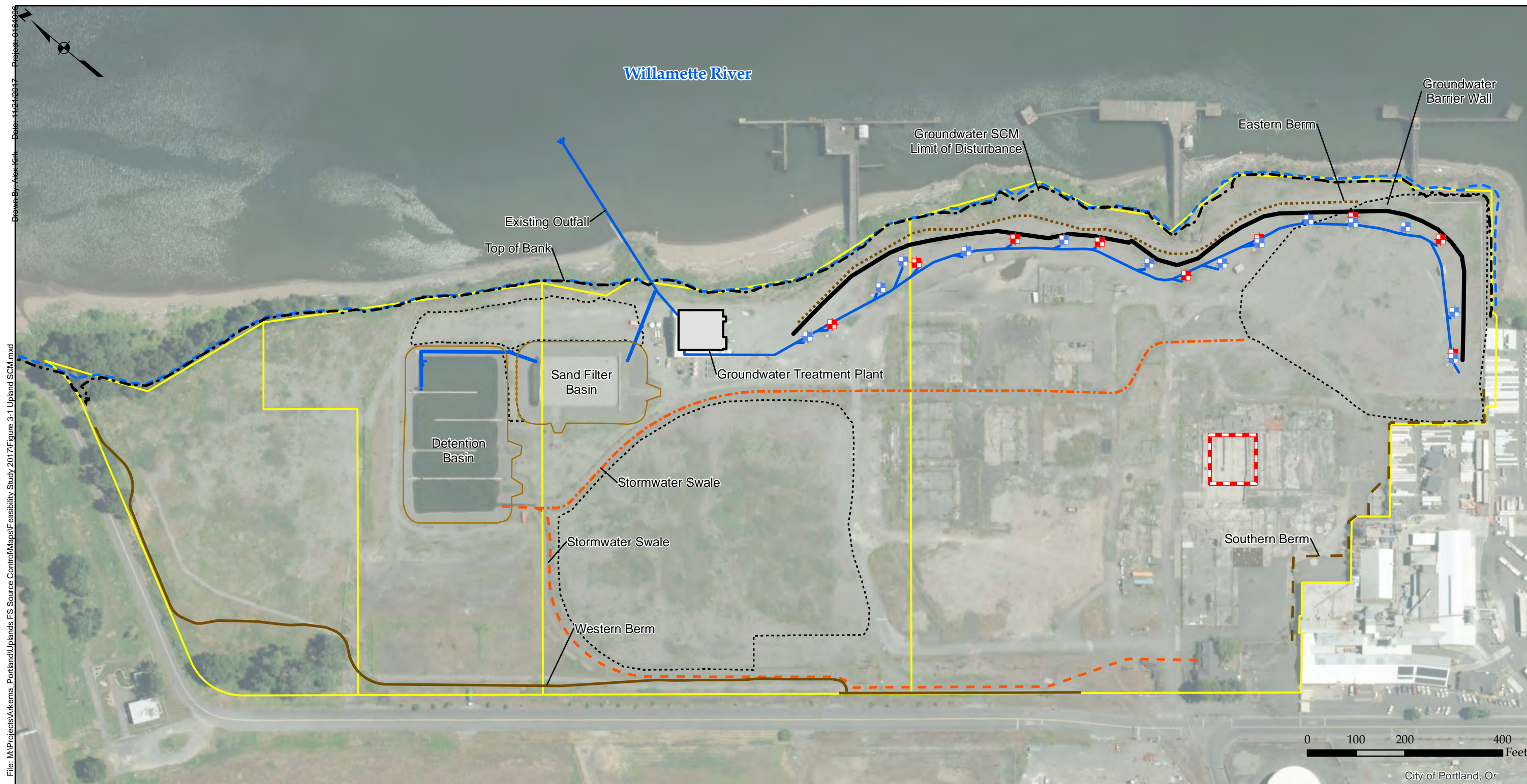
- Lot Boundaries
- Site Boundary

Note:

A number of the buildings and structures noted on this diagram have been demolished and/or removed.

Aerial Photo: City of Portland, September 2016

Figure 2-2
Site Layout
Revised Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon



Legend

■ Shallow Zone Recovery Well	--- Eastern Berm	■ Soil Management Area
■ Intermediate Zone Recovery Well	--- Eastern Stormwater Swale	--- Parcel and Property Boundaries
--- Top of Bank	--- Western Stormwater Swale	
--- 100-yr Flood Plain (32.5 feet NAVD88)	--- Underground Water	
--- Barrier Wall Alignment	--- Conveyance Piping	
--- Western Berm	--- Pond Boundary	
--- Southern Berm	--- Areas to be Filled	

Figure 3-1

Upland Source Control Measures Layout

Revised Feasibility Study Work Plan

Arkema Inc.

Portland, Oregon

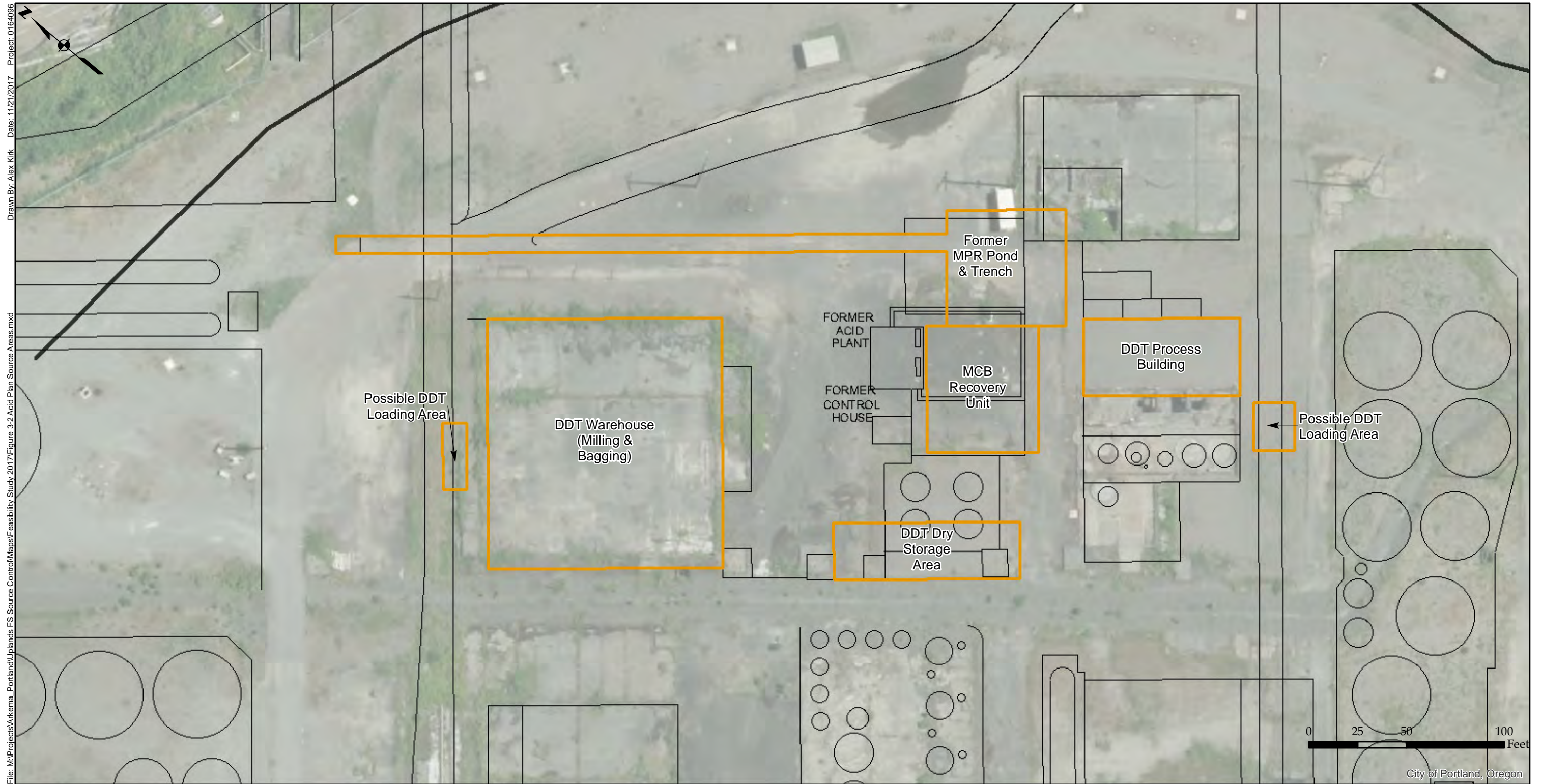
1 inch : 200 feet

Aerial Photo: City of Portland, Summer 2016

Environmental Resources Management

1001 SW 5th St, Suite 1010

Portland, Oregon 97204



Legend

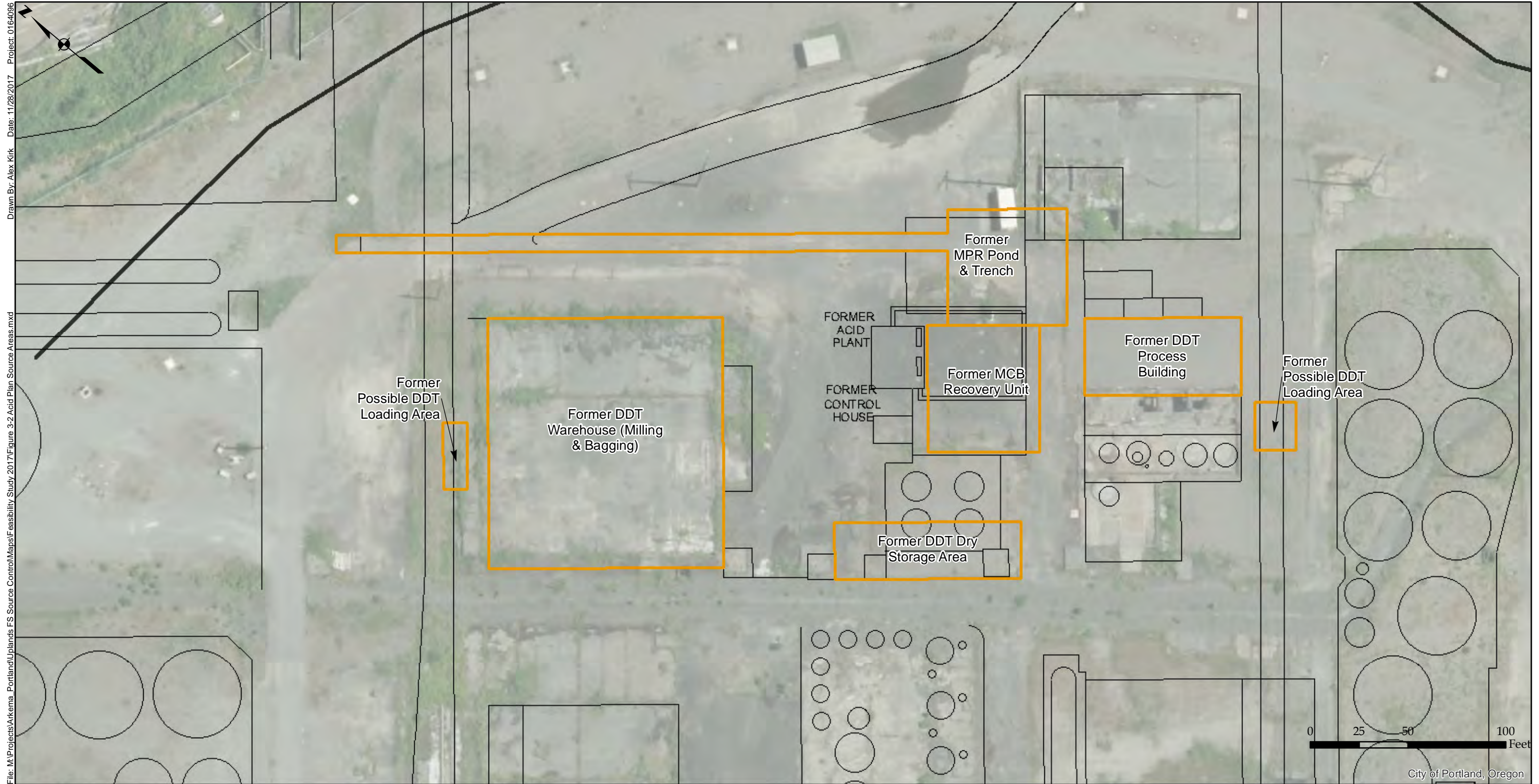
- Barrier Wall Alignment
- Approximate Acid Plant Source Areas

Note:
Most buildings and structures shown on this figure
have been demolished and/or removed.

Figure 3-2
Acid Plant Area
Revised Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

1 inch : 50 feet

Aerial Photo: City of Portland, Summer 2016



Legend

- Barrier Wall Alignment
- Approximate Acid Plant Source Areas

Note:
Most buildings and structures shown on this figure
have been demolished and/or removed.

Figure 3-2
Acid Plant Area
Revised Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

1 inch : 50 feet

Aerial Photo: City of Portland, Summer 2016



File: M:\Projects\Arkema_Portland\Uplands FS Source Control\Maps\Feeability Study 2017\Figure 3-3 Injection Wells.mxd
 Drawn By: Simon Ross Date: 11/21/2017 Project: 0164096

Legend

- | | |
|--|-------------------------|
| Direct Push Injection Points | Existing Injection Well |
| Round 1, Shallow Zone | Site Boundary |
| Round 1, Shallow and Intermediate Zone | Lot Boundaries |
| Round 1, Deep Zone | |
| Round 2, Shallow Zone | |
| Round 2, Shallow and Intermediate Zone | |

1 inch : 200 feet

Aerial Photo: City of Portland, Summer 2016

Figure 3-3
 Hexavalent Chromium Reduction IRM Injection Locations
 Revised Feasibility Study Work Plan
 Arkema Inc.
 Portland, Oregon

Note:
 A number of the buildings and structures
 noted on this diagram have been demolished
 and/or removed.

Tables

Table 4-1
Human Health and Ecological Risk Assessment Summary
Feasibility Study Work Plan
Arkema Inc. Portland, Oregon

Risk Assessment	Receptor	Potential Receptor Pathway		ODEQ RBDM Exposure Pathway	COPECs COC with Non-Cancer Risk		Compounds Exceeding RBDM SLVs	COPECs COC with Carcinogenic Risk(a)			COC Ecological Risk
		Area of Site	Exposure Depth		Hazard Index > 1	Hazard Index > 10		Carcinogenic Risk > 1 x 10 ⁻⁶	Carcinogenic Risk > 1 x 10 ⁻⁵	Carcinogenic Risk > 1 x 10 ⁻⁴	Hazard Quotient >1
Human Health	Trespasser	Lots 1 & 2	0-3 ft	Residential	--	--	As, BaA, BaP, BbF, IcdP, Aroclor 1248, 4,4-DDD, 4,4- DDE, 4,4-DDT, TCDD TEQ ¹	As, 4,4-DDT, TCDD TEQ ¹	--	- -	N/A
		Riverbank	0-3 ft	Residential	--	--	As, Cr, Pb, BaA, BaP, BbF, BkF, DBahA, IcdP, Aroclor 1248, 4,4- DDE, 4,4-DDT, Alpha-BHC, TCDD TEQ	As, TCDD TEQ	--	- -	N/A
	Indoor Worker	Lots 3 & 4	0-15 ft	Occupational Worker	--	--	1,4-Dichlorobenzene, PCE	1,4-Dichlorobenzene, PCE	--	- -	N/A
	Outdoor Worker	Lots 1 & 2	0-3 ft	Occupational Worker	--	--	As, BaP, 4,4-DDT, TCDD TEQ ¹	As, 4,4-DDT, TCDD TEQ ¹	As	- -	N/A
		Lots 3 & 4	0-3 ft	Occupational Worker	4,4-DDT (2.3)	--	Aroclor 1248, 4,4-DDD, 4,4-DDE, 4,4-DDT, Alpha- BHC, MCB, TCDD TEQ ¹	4,4-DDD, 4,4-DDE, 4,4-DDT, TCDD TEQ ¹	4,4-DDD	4,4-DDD	N/A
		Riverbank	0-3 ft	Occupational Worker	--	--	As, Cr, Pb, BaP, BbF, DBahA, 4,4-DDT, TCDD TEQ	As, TCDD TEQ	As	- -	N/A
	Outdoor Worker (Redevelopment)	Lots 1 & 2	0-15 ft	Occupational Worker	--	--	As, BaP, 4,4-DDT, TCDD TEQ ¹	As, 4,4-DDT, TCDD TEQ ¹	As	- -	N/A
		Lots 3 & 4	0-15 ft	Occupational Worker	4,4-DDT (2.3)	--	Aroclor 1248, 4,4-DDD, 4,4-DDE, 4,4-DDT, Alpha- BHC, MCB, TCDD TEQ ¹	4,4-DDD, 4,4-DDE, 4,4-DDT, TCDD TEQ ¹	4,4-DDD	4,4-DDD	N/A
		Riverbank	0-3 ft	Occupational Worker	--	--	As, Cr, Pb, BaP, BbF, DBahA, 4,4-DDT, TCDD TEQ	As, TCDD TEQ	As	- -	N/A
	Construction Worker	Lots 1 & 2	0-15 ft	Construction Worker	--	--	As, 4,4-DDT	As	--	- -	N/A
		Lots 3 & 4	0-15 ft	Construction Worker	4,4-DDT (7.6)	--	Cr, Aroclor 1248, 4,4-DDD, 4,4-DDE, 4,4-DDT, MCB	4,4-DDT	4,4-DDD	- -	N/A
		Riverbank	0-15 ft	Construction Worker	--	--	As, Cr, Pb, TCDD TEQ	As, TCDD TEQ	--	- -	N/A
	Excavation Worker	Lots 1 & 2	0-15 ft	Excavation Worker	--	--	--	--	--	- -	N/A
		Lots 3 & 4	0-15 ft	Excavation Worker	--	--	Cr, 4,4-DDT	--	--	- -	N/A
		Riverbank	0-15 ft	Excavation Worker	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Indoor Worker	Site Wide	All Aquifers	Occupational Worker	--	--	Chloroform, 1,4-Dichlorobenzene	Chloroform, 1,4-Dichlorobenzene	-	- -	N/A
Ecological	Plant	Lots 1 & 2, Riverbank	0-3 ft	Plant	N/A	N/A	Cr ³ , Pb, N/A	N/A	N/A	N/A	Cr, Pb, beta HCH ¹ , As ¹ , Cu ¹ , Zn ¹
	Invertebrate	Lots 1 & 2, Riverbank	0-3 ft	Invertebrate	N/A	N/A	Cr ³ , Pb N/A	N/A	N/A	N/A	Cr ¹ , Pb
	Bird	Lots 1 & 2, Riverbank	0-3 ft	Bird	N/A	N/A	Cr, Pb, DDX N/A	N/A	N/A	N/A	Cr, Pb, DDX, DDD ¹ , DDE ¹ , DDT ¹ , TCDD TEQ ¹ , PCBs ¹ , As ¹ , Cu ¹ , Zn ¹
	Mammal	Lots 1 & 2, Riverbank	0-3 ft	Mammal	N/A	N/A	Pb, DDX, N/A	N/A	N/A	N/A	Pb ² , DDX, , DDD ¹ , DDE ¹ , DDT ¹ , PCBs ¹ , TCDD TEQ ¹ , alpha-HCH ¹ , BEHP ¹ , As ¹ , Cu ¹ , Zn ¹

Notes:
(a) = Carcinogenic risk at the Reasonable Maximum Exposure (RME) concentration, calculated using the 90% upper confidence limit of the mean.
DDT = Dichloro-diphenyl-trichloroethane
DDD = Dichloro-diphenyl-dichloroethane
DDE = Dichloro-diphenyl-chloroethane
DDX = Sum Total of DDD, DDE, and DDT
DEQ = Oregon Department of Environmental Quality
RBDM =Risk-Based Decision Making, Oregon Department of Environmental Quality. Risk-Based Decision Making (October 2008).
SLV = Screening Level Value
TCDD TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Quotient
As = Arsenic
BaA = Benzo(a)anthracene
BaP = Benzo(a)pyrene
BbF = Benzo(b)fluoranthene
IcdP = Indeno(c,d)pyrene
Alpha-BHC = Lindane
BkF = Benzo(k)Fluoranthene
Cr = Chromium
DBahA = Dibenzo(a,h)anthracene
Pb = Lead
N/A = Not Applicable
-- = No Exceedence

¹ Per DEQ's March 15, 2010 modification to the Arkema Level II Screening Ecological Risk Assessment
² Per January 16, 2009 Arkema Upland Level II Screening Ecological Risk Assessment
³ 2,3,7,8-TCDD TEQ added based on catch basin results see Section 4.1.3.

Table 4-2
Hot Spot Receptor Pathway Evaluation
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

Note: DEQ has directed Arkema to update and revise this table in the revised Preliminary Hot Spot Evaluation

Type of Hot Spot		Rationale for Screening Criteria	Note	Potential Receptor Pathway		DEQ Mandated Hot Spot Screening Values to be Used	Data Set to be Screened	Compounds
				Area of Site	Receptor Pathway			
<u>Groundwater</u>								
1	Preliminary Groundwater Hot Spot - Indirect Exposure (Groundwater discharge to Willamette River)	Per DEQ comments, lowest of applicable screening criteria from DEQ Table 30, EPA NRWQC, and DEQ Table 40 were selected. Where chronic AWQC are not available, the lowest DEQ Table 31 or ORNL, or DEQ provided values were used.	Beneficial use classification is recharge to surface water for aquatic habitat.	Site Wide	Transition Zone Porewater/Surface Water	ODEQ AWQC, EPA NRWQC, or ORNL	August 2006 Dioxins and Furans Data Gaps Assessment Sampling, April 2007, August 2009, and January 2010 Groundwater Monitoring data.	Metals, VOCs, SVOCs, Pesticides, and Dioxin and Furans for which data and screening criteria are available, and Chloride and Perchlorate^(b)
<u>Soil</u>	Preliminary Groundwater Hot Spot - Direct Exposure	Risk-based values from HHRA for receptor pathways with potential "Unacceptable Risk" ^(a)	Only calculated for pathways resulting in potential unacceptable risk(a) calculated in HHRA; screening values are pathway-specific.	Site Wide	Indoor Worker	10x Site Specific RBC	August 2006 Dioxins and Furans Data Gaps Assessment Sampling, April 2007, August 2009, and January 2010 Groundwater Monitoring data.	Chloroform, PCE
3	Preliminary Highly Concentrated Hot Spot - Human Exposure	Risk-based values from HHRA for receptor pathways with potential "Unacceptable Risk" ^(a)	Only calculated for pathways resulting in potential unacceptable risk ^(a) calculated in HHRA; screening values are pathway-specific.	Lots 1 & 2	Outdoor Worker - Cancer	100x Site Specific RBC	Lot 1& 2 Soil (0-3 ft)	As, DDT
					Outdoor worker after redevelopment - Cancer	100x Site Specific RBC	Lot 1& 2 Soil (0-15 ft)	As, DDT
				Lots 3 & 4	Outdoor worker - Cancer	100x Site Specific RBC	Lot 3 & 4 Soil (0-3 ft)	DDT, DDD, DDE
					Outdoor worker after redevelopment - Cancer	100x Site Specific RBC	Lot 3 & 4 Soil (all)	DDT, DDD, DDE
					Construction worker - Cancer	100x Site Specific RBC	Lot 3 & 4 Soil (0-15 ft)	DDT
					Indoor Worker	100x Site Specific RBC	Lot 3 & 4 Soil (0-15 ft)	1,4 DCB, PCE
4	Preliminary Highly Concentrated Hot Spot - Ecological Receptors	Risk-based values from BERA for receptor pathways with potential Unacceptable Risk. No Threatened or Endangered Species identified.	Only calculated for pathways resulting in potential unacceptable risk as identified in BERA.	Lots 1 & 2, Riverbank	Plant	10x Ecological SLV	Lots 1 and 2 data; Soil <1 foot	Cr, Pb
					Invertebrate	10x Ecological SLV	Lots 1 and 2 data; Soil <1 foot	Cr
					Bird	10x Ecological SLV	Lots 1 and 2 data; Soil <1 foot	Cr, Pb, DDX^(c)
					Mammal	10x Ecological SLV	Lots 1 and 2 data; Soil <1 foot	DDX^(c)
5	Preliminary Highly Mobile Hot Spot	Derived from selected Groundwater Preliminary Hot Spot criteria	Only perform if levels lower than "highly concentrated" values	Site Wide	Leaching to Groundwater	Derived from selected Groundwater Preliminary Hot Spot criteria	All soil data, excluding Acid Plant Area soil data prior to removal IRM	Metals, VOCs, SVOCs, Pesticides, Dioxin and Furans, Chloride, and Perchlorate for which concentrations in groundwater exceeded provided screening criteria^(d)
<u>Other</u>								
6	Preliminary DNAPL	Yes/no presence of DNAPL in sample	Use DNAPL delineation report findings	Site Wide	N/A	Presence/Absence	All soil and groundwater	DNAPL
7	Preliminary Not Reliably Containable	Criterion in Feasibility Study	To Be Determined during Feasibility Study	N/A	N/A	N/A	N/A	N/A

Notes:

^(a) = Unacceptable risk under a deterministic risk assessment is defined as greater than 1 x 10E-5 for sum of all carcinogenic compounds; greater than 1 x 10E-6 for individual carcinogenic compounds; or a Hazard Index greater than 1 for non-carcinogenic compounds.

^(b) = COCs presented on Table 4-4

^(c) = Excludes dioxins and furans. Risk to terrestrial receptors will be addressed per agreements reached with DEQ (email comm 3 September 2013)

^(d) = COCs presented in Table 4-5

Ecological soil screening values were adopted in the following order of decreasing priority: EPA Eco-SSLs, Oregon DEQ Guidance, ORNL, and EPA Region 4 or EPA Region 5.

AWQC = Ambient Water Quality Criteria, Table 20 from OAR 340-040 (2004)

COC = Chemical of Concern

DNAPL = Dense Non-Aqueous Phase Liquid

DAF = Dilution and Attenuation Factor

DDT = Dichloro-diphenyl-trichloroethane

DDD = Dichloro-diphenyl-dichloroethane

DDE = Dichloro-diphenyl-chloroethane

DEQ = Oregon Department of Environmental Quality

HHRA = Human Health Risk Assessment

Hot Spot Guidance = Oregon Department of Environmental Quality, *Guidance for Identification of Hot Spots* (April 1998)

JSCS SLV = Joint Source Control Strategy Screening Level Values from *Portland Harbor Joint Source Control Strategy Final December 2005, Table 3-1*.

MCL =Maximum Contaminant Level (USEPA. *Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update.* Sept 2008).

N/A = Not Applicable

PECs = MacDonald DD, Ingersoll C.G., Berger T.A. (2000). Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Environmental Contaminations and Toxicity* 39: 20-31.

PRG = Preliminary Remediation Goal, (USEPA. *Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update.* Sept 2008).

RBC = Risk-Based Concentration

RBDM =Risk-Based Decision Making, Oregon Department of Environmental Quality. *Risk-Based Decision Making* (October 2008).

SBV = Screening Benchmark Values, Oregon Department of Environmental Quality, *Guidance for Ecological Risk Assessment - Level II Screening Benchmark Values* (April 1998)

TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Quotient

Note: DEQ has directed Arkema to update and revise this table in the revised Preliminary Hot Spot Evaluation

Type of Screening		Risk Based Decision Making Screening Levels										Highly Concentrated Hot Spot Screening Levels ^(d)									
Exposure/Receptor Pathway	Background Concentration	Human Exposure ^(b)						Ecological Receptors ^(c)				Human Exposure ^(b)						Ecological Receptors ^(c)			
		Trespasser	Indoor Worker	Outdoor Worker	Construction Worker	Excavation Worker	Indoor Worker	Plant	Bird	Mammal	Invertebrates	Trespasser	Indoor Worker	Outdoor Worker	Construction Worker	Excavation Worker	Indoor Worker	Plant	Bird	Mammal	Invertebrates
Media		Soil	Soil	Soil	Soil	Soil	Groundwater	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Groundwater	Soil	Soil	Soil	Soil
Contaminant of Concern	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Hot Spot Multiplier ^(d)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	100	100	100	100	100	10	10	10	10
Inorganics																					
Arsenic (total)	8.8	11 0.43	--	1.9	15	--	--	18	43	46	--	1,100 43	--	190	1,500-970	--	--	180	430	460	--
Chromium (III)	76	120,000	--	--	530,000	--	--	1	26	--	0.4	>Max	--	--	>Max	--	--	10	260	--	4
Chromium (VI)	--	0.30	--	6.3	49	1,400	--	--	--	--	--	--30	--	--630	--4,900	--140,000	--	--	--	--	--
Copper	--	--	--	--	--	--	--	70	28	49	--	--	--	--	--	--	--	700	280	490	--
Lead	79	400	--	800	800	800	--	120	11	--	1,700	--	--	--	--	--	--	1,200	110	--	17,000
Zinc	180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Perchlorate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organics																					
1,4'-Dichlorobenzene	--	--	13	--	--	--	13-7,100	--	--	--	--	--	--	--	--	--	1,300	--	--	--	--
Chlorobenzene	--	--	--	8,700	4,700	--	--	--	--	--	--	--	--	--87,000	--	--47,000	--	--	--	--	--
Chloroform	--	--	--	--	--	--	1,600	--	--	--	--	--	--	--	--	--	160,000	--	--	--	--
Tetrachloroethene (PCE)	--	--	36	1,000	--	--	--	--	--	--	--	--	3,600	--43,000	--	--	--	--	--	--	--
Benzo(a)anthracene	--	0.15-1.1	--	--	--	--	--	--	--	--	--	--110	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	0.015 0.11	--	0.29-2.1	--	--	--	--	--	--	--	--11	--	--210	--	--	--	--	--	--	--
BaP equivalents	--	0.11	--	2.1	--	--	--	--	--	--	--	11	--	210	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	0.15-1.1	--	2.9 21	--	--	--	--	--	--	--	--110	--	--2,100	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	1.5 11	--	--	--	--	--	--	--	--	--	--1,100	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl Phthalate	--	--	--	--	--	--	--	--	--	0.925 ¹	--	--	--	--	--	--	--	--	--	9.25	--
Dibenzo(a,h)anthracene	--	0.015 0.11	--	0.29-2.1	--	--	--	--	--	--	--	--11	--	--210	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	0.15-1.1	--	--	--	--	--	--	--	--	--	--110	--	--	--	--	--	--	--	--	--
4,4'-DDD and 2,4'-DDD	--	2.7 2.2	--	12	94 9.7	--270	--	--	0.093	0.021	--	--22	--	1,200310	--97	--	--	--	0.93	0.21	--
4,4'-DDE and 2,4'-DDE	--	1.8	--	8.2	66	--	--	--	0.093	0.021	--	--180	--	820	--6,600	--	--	--	0.93	0.21	--
4,4'-DDT and 2,4'DDT	--	1.9	--	8.5	66	1800	--	--	0.093	0.021	--	190	--	850	6,6001,600	--	--	--	0.93	0.21	--
DDX	--	--	--	--	--	--	--	--	0.093	0.021	--	--	--	--	--	--	--	--	0.93	0.21	--
Alpha-Hexachlorocyclohexane	--	0.086	--	0.36	--	--	--	--	0.0025	0.0025	--	--8.6	--	--36	--	--	--	--	0.025	0.0025	--
Beta-Hexachlorocyclohexane	--	--	--	--	--	--	--	0.00398 ¹	--	--	--	--	--	--	--	--	--	0.0398	--	--	--
PCBs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated biphenyls (PCBs)	--	--	--	--	--	--	--	--	--	0.05 ²	--	--	--	--	--	--	--	--	--	0.5	--
Aroclor 1248	--	--	--	--	--	--	--	--	--	0.05 ²	--	--	--	--	--	--	--	--	--	0.5	--
Aroclor 1260	--	--	--	--	--	--	--	--	0.7 ²	0.05 ²	--	--	--	--	--	--	--	--	7	0.5	--
PCB TEQ	--	--	--	--	--	--	--	--	2E-06	--	--	--	--	--	--	--	--	--	2E-05	--	--
2,3,7,8-TCDD TEQ	--	0.0000047	--	0.000016	0.00017	--	--	--	1BD-0.000055	1BD0.00012	1BD	0.00047	--	0.0016	--	--	--	--	TBD ³	TBD ³	TBD ³

Notes:

-- = Criteria not available, or compound screened out based on Human Health Risk Assessment or Baseline Ecological Risk Assessment.

N/ A = not applicable

Value from EPA Region 6 Outdoor Workere MSSL used when RBC not available.

^(a) = Oregon Department of Environmental Quality, Guidance for Identification of Hot Spots (April 1998)

^(b) = Human Exposure Pathways with unacceptable risk as determined in Human Health Risk Assessment, Arkema Site: Upland Areas, Integral, May 2008

^(c) = Ecological Exposure Pathways with eceedences of ODEQ Level II Screening Level Values as determined in Draft Arkema Upland Level II Screening Ecological Risk Assesement, Integral Consulting, February 2008

^(d) = Human Health Hazard Quotient less than 10 Ecological Exposure Pathways with unacceptable risk as determined in Draft Arkema Upland Level II Screening Ecological Risk Assesement, Integral Consulting, February 2008

mg/kg = milligrams per kilogram

ug/L = micrograms per liter

RBDM =Risk-Based Decision Making, Oregon Department of Environmental Quality. Risk-Based Decision Making (updated June 2012).

SBV = Screening Benchmark Values, Oregon Department of Environmental Quality, Guidance for Ecological Risk Assessment - Level II Screening Benchmark Values (April 1998)

TCDD TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Quotient

DDT = Dichloro-diphenyl-trichloroethane

DDD = Dichloro-diphenyl-dichloroethane

DDE = Dichloro-diphenyl-chloroethane

DEQ = Oregon Department of Environmental Quality

HHRA = Human Health Risk Assessment

¹ EPA Region 5 as presented in DEQ’s March 15, 2010 modification of the Arkema Upland Level II Screening, Ecological Risk Assessment.

² DEQ/EPA calculated bioaccumulation SLVs

³ 2,3,7,8-TCDD ecological hot spot vale to be developed if needed during Feasibility Study. See section 4.2.2.

⁴ Human health highly concentrated hot spot levels based on a 100-fold multiplier of the acceptable risk levels for carcinogens and a 10 10 multiplier for non-carcinogens. For contaminants that pose both a carcinogen and non-carcinogen the lowest resulting value was used. Human health hot spot concentration values are taken from DEQ’s Hot Spot Concentration table from the May 2018 RBCE Guidance update.

Table 4-4
Indirect Exposure Pathway Based **Screening Criteria-Hot Spot Criteria**
(Groundwater Discharge to Willamette River)
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

Note: DEQ has directed Arkema to update and revise this table in the revised Preliminary Hot Spot Evaluation

Type of Hot Spot		Highly Concentrated		Preliminary Groundwater									
Media		Groundwater		Groundwater									
Exposure Pathway		Indoor Worker Vapor Intrusion ^(c)		In-Water Receptor (Transition Zone Porewater)									
				Criteria				Guidance		Background Value	EPA MCL	DEQ Provided Value	Selected Hot Spot Criteria (Numeric RAOs for RAO 6)
Detected Contaminant ^(a) of Concern		RBC	Hot Spot Criteria	AWQC Table 30 (CCC)	EPA NRWQC (Eco CCC)	HHWQC ⁽¹⁾ Table 40	EPA NRWQC (HH) ⁽¹⁾	AWQG Table 31 Chronic	Oak Ridge National Laboratory				
Units	CAS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Metals													
Aluminum	7429905				87								87
Antimony	7440360					64	640	1,600	30		6		64
Arsenic ^(a)	7440382			150	150		0.14		3.1	3 - 5			2.1
Arsenic (inorganic)	7440382					2.1					10		2.1
Beryllium	7440417							5.3	0.66		4		0.66
Cadmium ^(b)	7440439			0.094	0.72						5		0.094
Chromium III ^(b)	16065831			23.81	74								23.81
Chromium VI	18540299			11	11								11
Copper	7440508			0.012							1300		0.012
Iron (total)	7439896			1,000	1,000								1,000
Lead ^(b)	7439921			0.54	2.5						15		0.54
Manganese ^(d)	7439965					100	100					430	430
Mercury (total)	7439976			0.012	0.77				1.3				0.012
Nickel ^(b)	7440020			16.10	52	170	4,600						16.10
Selenium	7782492			4.6		420	4,200				50		4.6
Silver	7440224			0.1									0.1
Thallium	7440280					0.047	0.47	40			2		0.047
Zinc ^(b)	7440666			36.50	120	2,600	26,000						36.50
Chloride	16887006			230,000	230,000								230,000
Perchlorate	14797-73-0											1,800	1,800
VOCs													
Trichloroethane 1,1,1	71556						200,000		11		200		200,000 11
Tetrachloroethane 1,1,2,2	79345					0.4	3	2,400					0.4
Trichloroethane 1,1,2	79005					1.6	8.9	9,400			5		1.6
1,1-Dichloroethane	75-34-3								47				47
Dichloroethylene 1,1	75354					710	20,000				7		710
Trichlorobenzene 1,2,4	120821					7	0.076		110		70		0.076
Dichlorobenzene(o) 1,2	95501					130	3,000		14		600		130 14
Dichloroethane 1,2	107062					3.7	650	20,000	910		5		3.7
Dichloropropane 1,2	78875					1.5	31	5,700			5		1.5
Dichlorobenzene(m) 1,3	541731					96	10		71				10
Dichlorobenzene(p) 1,4	106467					19	900		15		75		19 15
Dichlorobenzenes								763					763
2-Butanone (MEK)									14,000				14,000
Acetone	67641								1,500				1,500
Benzene	71432					1.4	16-58		130		5		1.4
Dichlorobromomethane	75274					1.7	27						1.7
Bromoform	75252					14	120				80		14
Carbon Disulfide									0.92				0.92
Carbon Tetrachloride	56235					0.16	5		9.8		5		0.16
Chlorobenzene	108907					160	800		64		100		160 64
Chloroform	67663	1,600	16,000			1,100	2,000	1,240	28		80		1,100 28
cis-1,2-Dichloroethene	156-59-2								590				590
Dichloropropene 1,3	542756					2.1		244					2.1
Chlorodibromomethane	124481					1.3	21						1.3
Ethylbenzene	100414					210	130		7.3		700		130 7.3
Hexachlorobutadiene	87683					1.8	0.01	9.3					0.01
m,p-Xylene									1.8				1.8
Methyl Bromide	74839					150	10,000						150
Methylene Chloride	75092					59	1,000		2,200		5		59
Naphthalene	91203							620	12				12
o-Xylene									13				13
Tetrachloroethylene	127184	48,000	480,000			0.33	29	840	98		5		0.33
Toluene	108883					1,500	520		9.8		1000		520 9.8
Trichloroethylene	79016					3	7	21,900	47		5		3
Dichloroethylene trans 1,2	156605					1,000	4,000				100		1,000
Vinyl Chloride	75014					0.24	1.6				2		0.24
SVOCs													
Acenaphthene	83329					99	90	520					90
Anthracene	120127					4,000	400		0.73				400 0.73
Benz(a)anthracene	56553					0.0018	0.0013		0.027				0.0013
Benzo(a)pyrene	50328					0.0018	0.00013		0.014		20		0.00013
Benzo(b)fluoranthene 3,4	205992					0.0018	0.0013						0.0013
Benzo(k)fluoranthene	207089					0.0018	0.013						0.0018
Chrysene	218019					0.0018	0.13						0.0018
Dibenz(a,h)anthracene	53703					0.0018	0.00013						0.00013
Fluoranthene	206440					14	20						14
Fluorene	86737					530	70		3.9				70 3.9
Indeno(1,2,3-cd)pyrene	193395					0.0018	0.0013						0.0013
Pyrene	129000					400	30						30
Pesticides													
Aldrin	309002					0.000005	0.0000007						0.0000007
BHC Alpha	319846					0.00049	0.00039		2.2				0.00039
BHC Beta	319-85-7					0.0017	0.014						0.0017
BHC Gamma (Lindane)	58899			0.08		0.18	4.4		0.08		20		0.08
Delta BHC	319-86-8												
Chlordane	57749			0.0043	0.0043	0.000081	0.00032				2		0.000081
Toxaphene	8001352			0.0002	0.0002	0.000028	0.00071				3		0.000028
Dieldrin	60571			0.056	0.056	0.0000054	0.0000012						0.0000012
Endosulfan Alpha	959988			0.056	0.056	8.9	30		0.051				0.056
Endosulfan Beta	33213659			0.056	0.056	8.9	40						0.056
Endosulfan Sulfate	1031078					8.9	40						8.9
Endosulfan	115297			0.056									0.056
Endrin	72208			0.036	0.036	0.024	0.03		0.061		2		0.024
Endrin Aldehyde	7421934					0.03	1						0.03
Heptachlor	76448			0.0038	0.0038	0.0000079	0.0000059		0.0069		40		0.0000059
Heptachlor Epoxide	1024573			0.0038	0.0038	0.0000039	0.000032				20		0.0000039
Hexachlorobenzene	118741					0.000029	0.000079				1		0.000029
Methoxychlor	72435			0.03	0.03		0.02				40		0.02
Mirex	2385855			0.001	0.001								0.001
DDD 4,4'	72548					0.000031	0.00012						0.000031
DDE 4,4'	72559					0.000022	0.000018						0.000018
DDT 4,4'	50293			0.001	0.001	0.000022	0.00003		0.013				0.000022
Dioxin and Furans													
Dioxin (2,3,7,8-TCDD)	1746016					0.00000000051	0.0000000051	0.000038	0.00038		0.00003		0.00000000051

Notes:
^(a) = Regional background Arsenic levels vary from 3-5 ug/L. Arsenic will be screened against the 2.1 ug/L.
^(b) = Ambient Water Quality Criteria is hardness dependant, and was calculated for a hardness of 25 mg/L.
^(c) = COCs identified in Human Health Risk Assessment (Integral Consulting 2008).
^(d) = Value provided in AAWQC and AWQG is for salt water only. Criteria provided in Portland Harbor ROD used as screening criteria

(1)=Human health for the consumption of Organism Only.

Table 4-5
Indirect-Exposure-Pathway-Based Screening Criteria
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

Type of Hot Spot		Selected- Groundwater Hot Spot- Criteria	Highly Mobile		
Media			Soil		
Exposure Pathway			Chemical Parameters		Leaching-to- Groundwater
Contaminant of Concern			K _{oc}	H	Soil Hot Spot Criteria
Units		ug/L	cm³/g	—	mg/kg
DAF		1			60
Metals					
Arsenic¹	7440382	2.1	NA	NA	NA
Arsenic (inorganic)	7440382	2.1	29	NA	3.68
Cadmium²	7440439	0.094	75	NA	0.42
Chromium-III²	16065831	23.81	1800000	NA	2,571,816
Chromium-VI	18540299	11	19	NA	12.66
Copper	7440508	0.012	NA	NA	NA
Iron (total)	7439896	1,000	25	NA	1,511
Manganese	7439965	430	65	NA	1,682
Mercury (total)	7439976	0.012	52	NA	0.0376
Nickel²	7440020	16.10	NA	NA	NA
Zinc²	7440666	36.50	62	NA	136
Inorganic					
Chloride	16887006	230,000	NA	NA	NA
Perchlorate	14797-73-0	1,800	NA	NA	NA
VOCs					
Dichlorobenzene(o)-1,2	95501	130	382.9	0.0784955	15.58
Dichlorobenzene(m)-1,3	541731	10	NA	NA	NA
Dichlorobenzene(p)-1,4	106467	19	375.3	0.098528	2.24
Benzene	71432	1.4	145.8	0.227	0.0701
Dichlorobromomethane	75274	1.7	31.82	0.087	0.0248
Carbon Disulfide		0.92	21.73	0.589	0.0149
Carbon Tetrachloride	56235	0.16	43.89	1.128	0.0044
Chlorobenzene	108907	160	233.9	0.127	12.09
Chloroform	67663	1,100	31.82	0.15	16.67
Chlorodibromomethane	124481	1.3	32	0.032	0.0184
Hexachlorobutadiene	87683	0.01	845.2	0.421096	0.0026
Methylene Chloride	75092	59	21.73	0.133	0.7065
Tetrachloroethylene	127184	0.33	94.94	0.724	0.0130
Trichloroethylene	79016	3	60.7	0.403	0.0784
Vinyl Chloride	75014	0.24	21.73	1.137	0.0051
Pesticides					
BHC Alpha	319846	0.00039	2807	0.0002101	0.0003
BHC Beta	319-85-7	0.0017	2800	0.000018	0.0014
BHC Gamma (Lindane)	58899	0.08	2807	0.0002101	0.0677
Chlordane	57749	0.000081	68000	0.002	0.0017
Dieldrin	60571	0.0000012	20090	0.0004088	0.00000724
Heptachlor	76448	0.0000059	41260	0.0120196	0.0001
Heptachlor Epoxide	1024573	0.0000039	10000	0.00086	0.00001172
DDD 4,4'	72548	0.000031	120000	0.00027	0.0011
DDE 4,4'	72559	0.000018	120000	0.0017	0.0006
DDT 4,4'	50293	0.000022	170000	0.00034	0.0011
Dioxin and Furans					
Dioxin (2,3,7,8-TCDD)	1746016	0.00000000051	249100	0.002044	3.81E-08

1—Regional background Arsenic levels vary from 3-5 ug/L. Arsenic will be screened against 2.1 ug/L.

2—Ambient Water Quality Criteria is hardness dependant, and was calculated for a hardness of 25 mg/L.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
<i>Federal</i>		
Federal Water Pollution Control Act/Clean Water Act (CWA) [33 USC Sections 1313, 1314, 1341 and 1344; 40 CFR Parts 131, 230]	The CWA establishes the basic structure for regulation of discharges of pollutants into the water of the United States. Section 404 (33 USC §1344) regulates the discharge of dredged material or fill into navigable waters. Section 401(33 USC §1341) requires state certification that a discharge will not violate state water quality standards.	The implementing regulations of the CWA are applicable to potential remedial actions in the riverbank and in-water early action.
Rivers and Harbors Appropriations Act [33 USC Section 403; 33 CFR Parts 230, 322]	The Rivers and Harbors Act prohibits unauthorized activities that obstruct or alter a navigable waterway. It controls the alteration of navigable waters (i.e., waters subject to ebb and flow of the tide shoreward to the mean high water mark). Activities controlled include construction of structures such as piers, berms, and installation of pilings. Section 10 may be applicable for any action that may obstruct or alter a navigable waterway.	The Rivers and Harbors Act regulations are applicable to potential remedial activities adjacent to the river.
Resource Conservation and Recovery Act (RCRA) [42 USC Section 6921; 40 CFR Parts 260, 261]	RCRA provides standards for the identification and management of solid and hazardous waste.	These regulations are applicable because waste materials generated as a result of removal or treatment actions that contain a listed or characteristic waste, if any, may be subject to RCRA requirements for storage, treatment, and disposal.
The Endangered Species Act (ESA) [16 USC Section 1536; 50 CFR Part 402]	The ESA requires an evaluation of a federal agency's action's impacts on listed (or proposed for listing) species of fish, wildlife, or plants.	The ESA regulations are applicable as riverbank remedial actions may potentially impact listed species in and adjacent to the Willamette River.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
Floodplain Management and Wetlands Protection [40 CFR Part 6 App. A and Executive Order 11988 and 11990]	Floodplain Management and Wetlands Protection requires federal agencies to conduct their activities to avoid, if possible, adverse impacts associated with the destruction or modification of wetlands and occupation or modification of floodplains. Executive Order 11988 requires federal projects to avoid adverse effects associated with construction in floodplains.	This regulation may be applicable because some remedial actions could at least in part be within a floodplain.
Magnuson-Stevens Fishery Conservation and Management Act [16 USC Section 1855(b); 50 CFR Part 600, subparts J-K]	Section 305(b) of the Magnuson-Stevens Act requires federal agencies to evaluate impacts to essential fish habitat (EFH) for activities that may adversely affect EFH.	This regulation is may be applicable because riverbank remedial actions may potentially impact EFH in the Willamette River.
Marine Mammal Protection Act [16 USC Section 1372]	EPA must ensure that the actions do not involve the unauthorized taking of marine mammals.	This regulation is unlikely to be applicable because marine species do not inhabit the lower Willamette River.
Hazardous Materials Transportation Act [49 USC Section 15101 <i>et seq.</i> ; 49 CFR Section 171-177]	Regulations provide for packaging, documentation, and transportation of hazardous waste (some RCRA requirements also apply).	This regulation is applicable if any material generated as a result of remedial actions is identified as hazardous waste and requires shipment for treatment or disposal.
National Historic Preservation Act (NHPA) [16 USC Sections 470h-2]	The NHPA requires EPA to consider the effects of remedial actions on historic properties.	This regulation is unlikely to be applicable because this site is not an historic property.
Archaeological and Historical Preservation Act (AHPA) [16 USC Sections 4699a-1]	In the event that significant scientific, prehistoric, or archaeological data are present on site, the AHPA requires EPA to approve the remedial activities so that such data are preserved.	This regulation is unlikely to be applicable because the site has not been shown to be an archaeological resource.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
Native American Graves Protection and Repatriation Act (NAGPR) [25 USC Section 3001 <i>et seq.</i>]	The NAGPR act requires federal agencies and museums with possession or control over Native American human remains and associated funerary objects to compile an inventory of such items. It requires federal agencies and museums with possession or control over Native American non-associated funerary objects, sacred objects, or objects of cultural patrimony to provide a written summary of such objects. It prescribes when a federal agency or museum must return Native American cultural items.	This regulation is only applicable if Native American remains or funerary objects are at the site, which, based on current information, is considered very unlikely.
National Pretreatment Standards for Discharges to publicly owned treatment works (POTW) [40 CFR Part 403]	The National Pretreatment Program identifies discharge standards to POTWs.	This regulation is potentially applicable to any discharges to a City of Portland POTW.
Safe Drinking Water Act (SDWA) [42 USC 300f <i>et seq.</i>]	The SDWA establishes maximum contaminant level (MCL) standards for the protection of drinking water sources.	This regulation is not applicable because the site is not impacting a drinking water source.
State and Local Requirements		
Oregon Water Quality Law (WQL) [ORS 468b.005 – 468b.095 (surface water) and ORS 468B.150-190 (groundwater); Oregon Water Quality Standards and Criteria, OAR Chapter 340, Divisions 40 and 41]	The WQL designates beneficial uses of water bodies and water quality standards and criteria necessary to protect those uses. In particular, OAR 340-041-0340 provides the beneficial water uses that shall be protected in the Willamette Basin. OAR 340-041-0442 through 340-041-0445 provide water quality standards for the State of Oregon. With respect to groundwater, OAR 340-0404-020 and 340-0404-0303(3)(b) define an “antidegradation policy to emphasize the prevention of groundwater pollution and to control waste discharges to	This regulation is likely applicable to groundwater and the Willamette River. Water quality standards may apply to discharge of treated groundwater.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
	groundwater so that the highest possible water quality is maintained."	
Oregon Regulations Pertaining to NPDES and WPCF Permits[OAR Chapter 340, Division 45]	The Oregon NPDES regulations establish discharge limits and monitoring requirements for direct discharges to surface waters.	The requirements of this regulation are potentially applicable to any direct discharges of treated water to the Willamette River.
Oregon Underground Injection Control (UIC) Rules [OAR Chapter 340, Division 44]	The Oregon UIC rules establish requirements for underground injection activities, including the construction, modification, or maintenance of any injection system. Under the UIC rules, it is prohibited to conduct any injection activity that would allow the direct or indirect movement of fluids containing contaminants into groundwater that may cause a violation of any primary drinking water regulation under the federal Safe Drinking Water Act, or fails to comply with groundwater quality protection requirements specified in OAR 340-040.	This regulation is potentially applicable to any subsurface injections conducted as part of a remedial action.
Oregon Solid Waste Management Act (SWMA) [ORS 459.005 <i>et seq.</i> ; OAR 340-094-0040]	The SWMA provides standards for the management and handling of solid wastes in Oregon.	This regulation is potentially applicable because disposal of non-hazardous waste materials may occur at a Subtitle D landfill.
Hazardous Waste Regulations [ORS 466.005-466.225; OAR Chapter 340-101-0033]	Hazardous waste regulations provide standards for the identification and management of hazardous wastes in Oregon.	This regulation is applicable if any material generated implementation of remedial actions is identified as hazardous waste and requires shipment for treatment or disposal in Oregon.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
Cleanup Standards [OAR 340-122-0040(2)(a), (4) and (6)]	The cleanup standards provide hazardous substance remedial action levels and requirements.	This regulation may be applicable to the establishment of cleanup levels and other requirements for remedial actions.
Indian Graves and Protected Objects (IGPO) [ORS 97.740 <i>et seq.</i>]	The IGPO protects human remains, funerary objects, sacred objects, and objects of cultural patrimony.	This regulation is only applicable if Native American remains or funerary objects are at the site, which, based on current information, is considered very unlikely.
Archaeological Objects Site [ORS 358.905 <i>et seq.</i>]	The archaeological objects laws protect archaeological objects and sites; requires notice upon discovery of artifacts.	This regulation is unlikely to be applicable because the site has not been shown to be an archaeological resource.
Visible Air Contaminant Limitations [OAR 340-208-0110]	The visible air contaminant limitations prohibit the emission of any air contaminant from a new source for a period or periods aggregating more than 3 minutes in any 1 hour that is equal to or greater than 20% opacity. These rules are for “special control areas” including Multnomah County.	This regulation is only applicable if remedial actions generate visible emissions of air contaminants.
Fugitive Emission Requirements (FER) [OAR 340-208-0200, 0210]	The FER prohibits any handling, transporting, or storage of materials, or use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. These rules are for “special control areas” including Multnomah County.	This regulation is potentially applicable only if material generated during implementation of a remedial action has very low water content and requires shipment, which is considered unlikely.
Lower Willamette River Management Plan (LWRMP) [ORS 273.045; OAR Chapter 141 Division 80]	The LWRMP provides policy direction and guidance to the Department of State Lands’ (DSL) regulatory and proprietary interests of the lower 17.5 miles of the Willamette River.	This regulation would likely be applicable to remedial actions in the riverbank.

Table 5-1
Preliminary Project ARARs
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

ARAR and Citation	Description	Applicability
Oregon Water Resources Department Willamette Basin Plan [OAR Chapter 690]	Oregon Water Resources Department (WRD) permit rules apply to any withdrawal of surface water from the Willamette River or groundwater from a well in the Willamette Basin. Production or recovery wells must also comply with WRD general standards for construction and maintenance of water wells (OAR Chapter 690, Division 200) and monitoring wells must comply with the appropriate standards for their construction and maintenance (OAR Chapter 690, Division 240).	This regulation is potentially applicable to the installation of groundwater extraction or monitoring wells as part of a remedial action.
Removal Fill Laws and Regulations (RFLR) [ORS 196.795 through 196.990; OAR Chapter 141, Division 85]	The RFLR define the requirements for dredging and filling activities and coordination of the permit requirements with federal regulations.	This regulation may be applicable if a remedial action requires dredging and/or filling in the Willamette River.
City of Portland Industrial Wastewater Discharge Limits [Section 17.34 of the Portland Code]	The City of Portland Industrial Wastewater Discharge Limits establishes discharge limits for industrial discharges to the City of Portland Sewer System. The City of Portland requires any “significant industrial user” to obtain a permit before discharging to the City of Portland Sewer System.	This regulation is potentially applicable to discharges from the site to the City of Portland Sewer System.
City of Portland Requirements for Greenway overlay zones [City of Portland Zoning Code Chapter 33.440]	The City of Portland has established Greenway overlay zones adjacent to the Willamette River to conserve natural, scenic, historical, economic, and recreational qualities and to promote public access, flood protection, and aesthetic factors. The regulations for Greenway overlays require that proposed development not be detrimental to the use and function of the river and abutting lands and must conserve, enhance, and maintain scenic qualities and natural habitat.	This regulation is potentially applicable to remedial activities at the site, as the site is located within a Greenway Heavy Industrial overlay zone.

Table 5-2
Estimated Hot-Spot Volumes in Soil
Preliminary Soil Hot Spots
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

Contaminant	Media	Zone	Pathway	Receptor	Top-Depth (ft)	Bottom-Depth (ft)	Thickness (ft)	Area (ft²)	Volume (ft³)
PCE	Soil	Surface	Direct-Contact	Indoor-Worker	0	3	3	8657	25971
TCDD-TEQ	Soil	Surface	Direct-Contact	Outdoor-Worker	0	3	3	1195269	3585807
TCDD-TEQ	Soil	Surface	Direct-Contact	Trespasser	0	3	3	124466	373399
Arsenic	Soil	Surface	Direct-Contact	Construction-Worker	0	15	15	214447	3216706
Arsenic	Soil	Surface	Direct-Contact	Outdoor-Worker	0	3	3	407926	1223779
Arsenic	Soil	Surface and Subsurface	Direct-Contact	Outdoor-Worker-After-Redevelopment	0	15	15	319706	4795594
Arsenic	Soil	Surface	Direct-Contact	Trespasser	0	3	3	220029	660088
Chromium	Soil	Surface	Direct-Contact	Ecological	0	3	3	12831	38492
DDT	Soil	Surface	Direct-Contact	Construction-Worker	0	15	15	96391	1445864
DDT	Soil	Surface	Direct-Contact	Ecological	0	3	3	625653	1876960
DDT	Soil	Surface	Direct-Contact	Outdoor-Worker	0	3	3	215357	646070
Lead	Soil	Surface	Direct-Contact	Ecological	0	3	3	10697	32092
DDT	Soil	Surface and Subsurface	Direct-Contact	Outdoor-Worker-After-Redevelopment	0	15	15	300879	4513183
DDT	Soil	Surface	Direct-Contact	Trespasser	0	3	3	460636	1381907
1,4-Dichlorobenzene	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	25893	647337
Alpha-BHC	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	9449	236234
Arsenic	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	853261	21331532
Cadmium	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	156355	3908863
Chlorobenzene	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	20183	504571
Cr6	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	37783	944568
Dieldrin	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	2358	58946
Heptachlor-Epoxide	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	2745	68636
Zinc	Soil	Deep	Leaching to Groundwater	Ecological	0	25	25	141847	3546163

Notes:

1 = Assumed porosity of 0.3 and saturation of residual DNAPL 5 percent

2 = Assumed porosity of 0.3 and saturation of residual DNAPL of 50 percent

ft = Feet

cy = cubic yards

DDT = Dichloro-diphenyl-trichloroethane

DNAPL = Dense Non-Aqueous Phase Liquid

TCDD-TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity-Equivalence Quotient

Table 5-3
Estimated Hot Spot Volumes in Groundwater
Preliminary Groundwater Hot Spots
Feasibility Study Work Plan
Arkema Inc.
Portland, Oregon

Aquifer Zone	Depth Interval	Arsenic	Benzene	Cadmium*	Chlordanes	Chloride	Chlorobenzene	Chloroform	Chromium	Cr6	DDT	Perchlorate	Dieldrin
	Volume	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)
Shallow	11	36,715,559	26,006,740	—	486,366	120,572,369	17,836,695	478,891	19,281,872	40,026,408	38,694,739	—	—
Intermediate	11	9,826,400	2,165,153	—	—	128,727,162	11,985,195	—	11,247,870	30,030,329	21,102,024	—	399,881
Deep	43	126,694,762	—	—	—	110,528,939	8,057,611	—	3,314,317	32,151,751	127,692,484	45,043,148	—
Basalt	63	114,712,225	3,765,068	—	—	285,997,202	79,520,443	—	1,968,744	—	10,414,633	—	—
Total		287,948,945	31,936,961	82,299,171	486,366	645,825,671	117,399,943	478,891	35,812,802	102,208,488	197,903,880	45,043,148	399,881

Aquifer Zone	Depth Interval	Heptachlor Epoxide	Heptachlor	Hexachlorobutadiene*	Iron	Lindane	Manganese	Nickel*	PCE	Perchlorate	TCE	TEQ	Vinyl Chloride
	Volume	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)
Shallow	11	—	3,314,196	—	62,051,186	5,543,580	38,661,647	—	34,968,629	9,478,103	5,118,751	117,231,699	8,032,173
Intermediate	11	194,592	732,824	—	19,224,113	405,764	68,130,978	—	12,817,729	17,731,095	1,367,626	145,388,879	6,341,917
Deep	43	—	—	—	3,235,007	—	136,384,931	—	—	—	—	4,666,530	7,826,783
Basalt	63	—	—	—	1,978,679	—	85,410,790	—	1,434,845	—	48,726,295	461,568,783	99,038,622
Total		194,592	4,047,020	7,044,844	86,488,985	5,949,344	328,588,346	47,572,470	49,221,203	27,209,198	55,212,672	728,855,891	121,239,495

Notes
—= no delineated hot spot
Volumes of intermediate, deep, and basalt zone calculated from the delineated areas and the thickness of each hydrostatic unit, as identified in the *Groundwater Modeling Report* (ERM March 2008).
Volumes in the shallow zone calculated from the delineated area and the difference between the highest groundwater levels (May 2015) and the bottom of the shallow zone.
Estimated porosity of all aquifer zones is 0.3
DDT = Dichloro-diphenyl-trichloroethane
gal = Gallons
*Total volumes calculated using sum depth of all aquifers

Table 5-4
Direct Exposure Pathway for Human Health Receptors
(RAO 1 and RAO4)
Preliminary Remedial Action Objectives
Feasibility Study Work Plan
Arkema Inc. Portland, Oregon

Remedial Action Objective			Preliminary Numerical Remedial Action Objectives RBDM SLVs ⁽¹⁾																			
Carcinogenic Risk Range			Preliminary Numeric RAO 1 (RBDM SLV) 1×10 ⁻⁶					Preliminary Numeric RAO 4 (Hot Spot Criteria) ⁴					1×10 ⁻⁵					1×10 ⁻⁴				
Human Health Receptor ⁽²⁾		Background	Trespasser ³	Indoor Worker (Vapor Intrusion)	Outdoor Worker	Outdoor Worker After Redevelopment	Construction Worker	Trespasser ³	Indoor Worker (Vapor Intrusion)	Outdoor Worker	Outdoor Worker After Redevelopment	Construction Worker	Trespasser	Indoor Worker	Outdoor Worker	Outdoor Worker After Redevelopment	Construction Worker	Trespasser	Indoor Worker	Outdoor Worker	Outdoor Worker After Redevelopment	Construction Worker
COPC																						
Inorganics (Soil)																						
Arsenic (total)	(mg/kg)	8.8	11-0.43	NR	1.9	1.9	15	43	--	190	190	970	NR	NR	19	NR	NR	NR	NR	NR	NR	NR
Chromium (III)	(mg/kg)	76	120,000	--	--	--	530,000	>Max	--	--	--	>Max										
Chromium (VI)	(mg/kg)	--	0.30	--	6.3	6.3	49	30	--	630	630	4,900										
Lead	(mg/kg)	79	400	--	800	800	800	4,000	--	8,000	8,000	8,000										
InoOrganics (Groundwater)																						
1,4 - Dichlorobenzene	(ug/L)	--	NR	7,100	NR	NR	NR	--	--	--	--	--	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chloroform	(ug/L)	--	NR	1,600	NR	NR	NR	--	--	--	--	--	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Organics																						
Tetrachloroethene (PCE)	(mg/kg)	--	NR	36	NR 1,000	NR	NR	--	--	43,000	--	--	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,4 - Dichlorobenzene	(mg/kg)	--	NR	13	NR	NR	NR	--	--	--	--	--										
Chlorobenzene	(mg/kg)	--	--	--	8,700	8,700	4,700															
Benzo(a)anthracene	(mg/kg)	--	1.1	--	--	--	--	110	--	--	--	--										
Benzo(a)pyrene	(mg/kg)	--	0.11	--	2.1	2.1	--	11	--	210	210	--										
BaP equivalents	(mg/kg)	--	0.11	--	2.1	2.1	--	11	--	210	210	--										
Benzo(b)fluoranthene	(mg/kg)	--	1.1	--	21	21	--	100	--	2,100	2,100	--										
Benzo(k)fluoranthane	(mg/kg)	--	11	--	--	--	--	1,100	--	--	--	--										
Dibenzo(a,h)anthracene	(mg/kg)	--	0.11	--	2.1	2.1	--	--	--	--	--	--										
Indeno(1,2,3-cd)pyrene	(mg/kg)	--	1.1	--	--	--	--	--	--	--	--	--										
4,4'-DDD and 2,4'-DDD	(mg/kg)	--	NR2.2	NR	11-12	11-12	NR9.7	22	--	310	310	97	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4,4'-DDE and 2,4'-DDE	(mg/kg)	--	NR 1.8	NR	7-6-8.2	7-6-8.2	NR66	180	--	820	820	6,600	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4,4'-DDT and 2,4'-DDT	(mg/kg)	--	1.9	NR	7-7-8.5	7-7-8.5	58-66	190	--	850	850	1,600	NR	NR	77	77	580	NR	NR	770	770	NR
alpha-Hexachlorocyclohexane	(mg/kg)	--	0.086	--	0.36	0.36	--	8.6	--	36	36	--										
2,3,7,8-TCDD TEQ	(mg/kg)	--	NR-0.0000047	NR	0.000015-0.000016	0.0000150.000016	NR 0.00017	0.00047	--	0.0016	0.0016	0.023	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

-- = Compound included in reference document, but no value assigned for specific pathway.
mg/kg = milligrams per kilogram
ug/L = micrograms per liter

1 = Numerical RAOs are based on RBCs from Oregon Department of Environmental Quality, Risk Based Decision Making for the Remediation of Petroleum Contaminated Sites, September 2003, updated June-2012May 2018.
2 = Human Exposure Pathways with unacceptable risk as determined in Human Health Risk Assessment, Arkema Site: Upland Areas, Integral, May 2008.
3 = Trespasser Numerical RAOs based on residential RBCs consistent with the Human Health Risk Assessment, Arkema Site: Upland Area
4 = Human health highly concentrated hot spot levels based on a 100-fold multiplier of the acceptable risk levels for carcinogens and a 10-fold multiplier for non-carcinogens. For contaminants that pose both a carcinogen and non-carcinogen the lowest resulting value was used. Human health hot spot concentration values are taken from DEQ’s Hot Spot Concentration table from the May 2018 RBCE Guidance update.

COPC = Contaminant of Potential Concern
COC = Contaminant of Concern based on Human Health Risk Assessment, Arkema Site: Upland Areas Tables 6-1 through 6-26.
RBDM =Risk-Based Decision Making
SBV = Screening Benchmark Values
TCDD TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Quotient
NR = No unacceptable risk
DDT = Dichloro-diphenyl-trichloroethane
DDD = Dichloro-diphenyl-dichloroethane
DDE = Dichloro-diphenyl-chloroethane

Table 5-5

Direct Exposure Pathway for Ecological Receptors (RAO 2)
Preliminary Remedial Action Objectives Feasibility Study
Work Plan
Arkema Inc.
Portland, Oregon

Media	Soil								
Type of Screening	Background Concentration	Screening Benchmark Levels-Preliminary Numeric Remedial Action Objective				Highly Concentrated Hot Spot Screening Levels			
Exposure/Receptor Pathway		Ecological Receptors ⁽³⁾				Ecological Receptors ⁽³⁾			
Contaminant of Concern	(mg/kg)	Plant	Bird	Mammal	Invertebrates	Plant	Bird	Mammal	Invertebrates
Hot Spot Multiplier		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		10	10	10	10	10	10	10	10
<i>Inorganics</i>									
Arsenic	8.8	18	43	46	--	180	430	460	--
Chromium (III)	76	1	26	--	0.4	10	26	--	4
Chromium (total)	76	76	76	--	76	76	260	--	76
Cooper		70	28	49	--	700	280	490	--
Lead	79	120	79	--	1,700	1200	110	--	17,000
<i>Organics</i>									
alpha-Hexachlorocyclohexane		--	0.0025	0.0025	--	--	0.025	0.025	--
Bis(2-ethylhexyl)Phthalate		--	--	0.925 ^a	--	--	--	9.25	--
beta-Hexachlorocyclohexane		0.00398 ^a	--	--	--	0.0398	--	--	--
DDX		--	0.093	0.021	--	--	0.93	0.21	--
PCBs				0.05 ^b				0.5	
Aroclor 1248				0.05 ^b				0.5	
Aroclor 1260			0.7 ^b	0.05 ^b			7	0.5	
PCB TEQ			2E-06				2E-05		
2,3,7,8-TCDD TEQ		--	TBD 5.5E-5	TBD 1.2E-04	TBD	--	TBD ^c	TBD ^c	TBD ^c

Notes

-- = Compound included in reference document, but no value assigned for specific pathway

mg/kg = milligrams per kilogram

ug/L = micrograms per liter

1 = Oregon Department of Environmental Quality, Guidance for Identification of Hot Spots (April 1998)

2 = Human Exposure Pathways with unacceptable risk as determined in Human Health Risk Assessment, Arkema Site: Upland Areas, Integral, May 2008

3 = Ecological Exposure Pathways with unacceptable risk as determined in Draft Arkema Upland Level II Screening Ecological Risk Assessment, Integral Consulting, February 2008 RBDM =Risk-Based Decision Making, Oregon Department of Environmental Quality. Risk-Based Decision Making (updated June 2012).

SBV = Screening Benchmark Values, Oregon Department of Environmental Quality, Guidance for Ecological Risk Assessment - Level II Screening Benchmark Values (April 1998)

TEQ = 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Quotient

NR = No unacceptable risk

DDT = Dichloro-diphenyl-trichloroethane

DDD = Dichloro-diphenyl-dichloroethane

DDE = Dichloro-diphenyl-chloroethane

DEQ = Oregon Department of Environmental Quality

^a = EPA Region 5 as presented in DEQ's March 15, 2010 modification of the Arkema Upland Level II Screening, Ecological Risk Assessment.

^b = DEQ/EPA calculated bioaccumulation SLVs

^c = 2,3,7,8-TCDD ecological hot spot value to be developed if needed during Feasibility Study. See section 4.2.2.

Table 5-6
RAO 5 Groundwater Discharge to Willamette River *Indirect Exposure Pathway for Ecological Receptors*
Preliminary Remedial Action Objectives
Feasibility Study Work Plan
Arkema Inc. Portland, OR

Note: DEQ has directed Arkema to update and revise this table in the revised Preliminary Hot Spot Evaluation

Media		Groundwater								Leaching to Groundwater
Detected Contaminant of Concern	CAS	Criteria				Guidance	Background Value	DEQ Provided Value	Selected Hot Spot Criterion Selected Preliminary Numeric RAO for ROA 5	Criteria
		AWQC Table 30 (CCC)	EPA NRWQC (Eco CCC)	HHWQC ⁽¹⁾ Table 40	EPA NRWQC ⁽¹⁾ (HH)	Oak Ridge National Laboratory				
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/kg
Metals										
Arsenic ^(a)	7440382	150	150	2.1	0.140.018	3.1	3 - 5		2.1	3.7 TBD
Cadmium ^(b)	7440439	0.094	0.72						0.094	0.42 TBD
Chromium III ^(b)	16065831	23.81	74						23.81	2,571,816 TBD
Chromium VI	18540299	11	11						11	43 TBD
Copper	7440508	0.012		1,300	1,300				0.012	NA TBD
Iron (total)	7439896	1,000	1,000						1,000	1,511 TBD
Manganese	7439965			400	400-50			430	430	1682 TBD
Mercury (total)	7439976	0.012	0.77			1.3			0.012	0.038 TBD
Nickel ^(b)	7440020	16.10	52	170 140	4,600 640				16.10	NA TBD
Zinc ^(b)	7440666	36.50	120	2,600-2,100	26,000 7,400				36.50	136 TBD
Chloride	16887006	230,000	230,000						230,000	NA TBD
Perchlorate	14797-73-0							1,800	1,800	NA TBD
VOCs										
Dichlorobenzene(o) 1,2	95501			130 110	3,000 1,000	14			130 14	46 TBD
Dichlorobenzene(m) 1,3	541731			96-80	40 7	71			40 7	NA TBD
Dichlorobenzene(p) 1,4	106467			49-16	900 300	15			49 15	2.2 TBD
Benzene	71432			1.4 0.44	16-58 0.58	130			1.4 0.44	0.070 TBD
Dichlorobromomethane	75274			1.7 0.42	27 0.95				1.7 0.42	0.025 TBD
Carbon Disulfide						0.92			0.92	0.015 TBD
Carbon Tetrachloride	56235			0.16 0.10	5 0.4	9.8			0.16 0.10	0.0044 TBD
Chlorobenzene	108907			160 74	800-100	64			160-64	42 TBD
Chloroform	67663			1,100-260	2,000 60	28			1,100 28	17 TBD
Chlorodibromomethane	124481			1.3 0.31	21 0.8				1.3 0.31	0.018 TBD
Hexachlorobutadiene	87683			1.8-0.36	0.01				0.01	0.0026 TBD
Methylene Chloride	75092			59 4.3	1,000 20	2,200			59 4.3	0.74 TBD
Tetrachloroethylene	127184			0.33 0.24	29 10	98			0.33-0.24	0.013 TBD
Trichloroethylene	79016			3 1.4	7 0.6	47			3 1.4	0.078 TBD
Vinyl Chloride	75014			0.24 0.023	1.6 0.022				0.24 0.022	0.0051 TBD
Pesticides										
BHC Alpha	319846			0.00049 0.00045	0.00039 0.00036	2.2			0.00039 0.00036	0.0033 TBD
BHC Beta	319-85-7			0.0017 0.0016	0.014 0.008				0.0017 0.0016	0.0014 TBD
BHC Gamma (Lindane)	58899	0.08		0.18 0.17	4.4 4.2	0.08			0.08	0.068 TBD
Chlordane	57749	0.0043	0.0043	0.000081	0.00032 0.00031				0.000081	0.0017 TBD
Dieldrin	60571	0.056	0.056	0.0000054 0.0000053	0.0000012				0.0000012	0.0000072 TBD
Heptachlor	76448	0.0038	0.0038	0.0000079	0.0000059	0.0069			0.0000059	0.000073 TBD
Heptachlor Epoxide	1024573	0.0038	0.0038	0.0000039	0.000032				0.0000039	0.000012 TBD
DDD 4,4'	72548			0.000031	0.00012				0.000031	0.0011 TBD
DDE 4,4'	72559			0.000022	0.000018				0.000018	0.00065 TBD
DDT 4,4'	50293	0.001	0.001	0.000022	0.00003	0.013			0.000022	0.0011 TBD
Dioxin and Furans										
Dioxin (2,3,7,8-TCDD)	1746016			0.00000000051	0.0000000051	0.00038			0.00000000051	0.000000038 TBD

Notes:
(a) = Regional background Arsenic levels vary from 3-5 ug/L. Arsenic will be screened against the 2.1 ug/L.
(b) = Ambient Water Quality Criteria is hardness dependant, and was calculated for a hardness of 25 mg/L.
(c) = COCs identified in Human Health Risk Assessment (Integral Consulting 2008). Hot Spot contaminant list will need to be revised based on results of Preliminary Hot Spot Evaluation. The contaminant list will need to be revised based on detected

(1)=Human health for the consumption of Water and Organism,

TBD = Leaching to groundwater hot spot criteria To Be Determined (TBD) in revised Preliminary Hot Spot Evaluation.

Table 5-7
RAO3 Soil Erosion to Willamette River
Preliminary Numerical Remedial Action Objectives
Feasibility Study Work Plan
Arkema Inc. Portland, OR

Media		Surface Soil and Riverbank Soil			
Contaminant ¹	CAS	JSCS SLV		Portland Harbor Cleanup Level	Preliminary Numerical RAO for RAO 3
		MacDonald PECs and other SQVs	DEQ 2007 Bioaccumulative Sediment SLVs		
Units		ug/kg	ug/kg	ug/kg	ug/kg
<i>Metals</i>					
Arsenic	7440-38-2	33,000	7,000	5,000	3,000
Cadmium	7440439	4,980	1,000	NA	1,000
Chromium	16065831	111,000		NA	111,000
Lead	7439-92-1	128,000	17,000	196,000	196,000
Zinc	7440-66-6	459,000		459,000	459,000
<i>PCBs</i>					
PCBs (Totals)		676	0.39	9	9
<i>Pesticides</i>					
Dieldrin	60-57-1	4.99		0.07	0.07
DDD (Total)	72-54-8	28	0.33	114	114
DDE (Total)	72-55-9	31.3	0.33	226	226
DDT (Total)	50-29-3	62.9	0.33	246	246
DDX (Total)			0.33	6.1	6.1
<i>SVOCs</i>					
Hexachlorobenzene	118-78-1	100	19	NA	19
<i>Phenols</i>					
Pentachlorophenol	87-86-5	1000	250	NA	250
<i>Phthalate Esters</i>					
Bis(2-Ethylhexyl)phthalate	117-81-7	800	330	135	135
<i>PAHs</i>					
Benzo(a)anthracene	56-55-3	1050		NA	1050
Benzo(g,h,i)perylene	191-24-2	300		NA	300
Chrysene	218-01-9	1290		NA	1290
Indeno(1,2,3-cd)pyrene	193-39-5	100		NA	100
PAHs-Total				23,000	23,000
cPAHs (BaP eq)				12	12
<i>Dioxin/Furans</i>					
2,3,7,8-TCDD	1746-07-6	0.09	0.00000091	0.0002	0.0002
1,2,3,7,8-PeDD	40321-76-4		0.0026	0.0002	0.0002
1,2,3,4,6,7,8-HpDD	35-822-46-9		0.69		0.69
2,3,7,8-TCDF	1746-01-6		0.00077	0.00040658	0.00040658
1,2,3,7,8-PeDF	57117-41-6		0.0026	0.003	0.003
2,3,4,7,8-PeDF	57117-14-6		0.00003	NA	0.00003
1,2,3,4,7,8-HxDF	70648-26-9		0.0027	0.0004	0.0004
1,2,3,6,7,8-HxDF	57117-44-9		0.0027	NA	0.0027
1,2,3,7,8,9-HxDF	72918-21-9		0.0027	NA	0.0027
2,3,4,6,7,8,9-HxDF	60851-34-5		0.0027	NA	0.0027
1,2,3,4,6,7,8-HpDF	67562-39-4		0.69	NA	0.69

Notes:

¹Contaminants based on contaminants exceeding JSCS SLVs as presented in December 2008 River Bank Erodible Soil Source Control Screening Evaluation Table 1.

Table 5-8
RAO 9 and 10 Stormwater Discharge to Willamette River
Preliminary Numerical Remedial Action Objectives
Feasibility Study Work Plan
Arkema Inc. Portland, OR

Media		Surface Soil and Riverbank Soil		
Contaminant ¹	CAS	JSCS SLV	Portland Harbor Cleanup Level for Surface Water	Preliminary Numerical RAO for RAO 9 and 10
Units		ug/L	ug/L	ug/L
<i>Inorganics</i>				
Arsenic	7440-38-2	0.045	0.018	0.018
Chromium VI	18540-29-9	11	100	100
Copper	7440-50-8	2.7	2.74	2.74
Zinc	7440-66-6	36	36.5	36.5
<i>Pesticides</i>				
DDD	72-54-8	0.000031	0.000031	0.000031
DDE	72-55-9	0.000022	0.000018	0.000018
DDT	50-29-3	0.000022	0.000022	0.000022
DDx		0.2	0.01	0.01
<i>SVOCs</i>				
Pentachlorophenol	87-86-5	0.56	0.03	0.03
<i>PAHs</i>				
Benzo(a)anthracene	56-55-3	0.0018	0.0012	0.0012
Benzo(a)pyrene	50-32-8	0.0018	0.00012	0.00012
Benzo(k)fluoranthene	207-08-9	0.0018	0.0013	0.0013
Chrysene	218-01-9	0.0018	0.0013	0.0013
Dibenzo(a,h)anthracene	53-70-3	0.0018	0.00012	0.00012
Indeno(1,2,3-cd)pyrene	193-39-5	0.018	0.0012	0.0012
cPAHs (BaP eq)		--	0.00012	0.00012
<i>Dioxin/Furans</i>				
Dioxin/Furans (2,3,7,8-TCDD eq)	1746-07-6	0.00000000051	0.0000000005	0.0000000005

¹Contaminant list based on contaminants identified in Attachment A of the Site's MAO for stormwater treatment system monitoring requirements that have a Portland Harbor Cleanup Level.

Attachment 2

DEQ Response on LSS's "Response to ODEQ (April 7, 2017) Comments

Table 1
Response to ODEQ Comments
Upland Feasibility Study Work Plan
Arkema Facility Portland

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
General Comments; Hot Spots				Blue=DEQ clarification and direction Red=Response not implemented in Work Plan as stated Green=Response acceptable
1	General Comment	The feasibility study work plan (FS Work Plan) states that application of AWQC to transition zone porewater (transition zone) is not appropriate to determine GW hot spots. DEQ concludes that the point of compliance for AWQC is the transition zone porewater for both human health (organism consumption) and aquatic life receptors. The revised FS Work Plan must update the groundwater hot spot screening accordingly.	<p>Comment noted. Screening in the Revised FS Work Plan assumes transition zone porewater (transition zone) as the compliance point for determining hot spots, at DEQ's request. In addition to screening groundwater concentrations to ambient water quality criteria (AWQCs), LSS will also screen groundwater and porewater to more appropriate values such as U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) or, if no MCL, an appropriate risk-based value.</p> <p>LSS will screen for hot spots using the AWQC and assuming that constituents in groundwater are transported unattenuated to the transition zone. LSS does not agree that the same assumptions are appropriate for determining action levels in the FS and designing a remedy. The action levels to be developed in the FS and the remedial design must accommodate new data and analysis that may demonstrate attenuation from concentrations in groundwater to the transition zone.</p> <p>LSS will consider whether the action levels to be developed in the FS should be based on new data and analysis that may demonstrate attenuation from concentrations in groundwater to the transition zone. If attenuation is demonstrated, then action levels for upland groundwater would be higher than the AWQCs that would apply in the transition zone.</p> <p>AWQC for several metal contaminants of concern (COCs) are hardness dependent. LSS intends to use the hardness observed in upland groundwater to calculate these criteria. The hardness in the Willamette River surface water is not appropriate for calculating upland groundwater screening criteria.</p>	<p>As documented in our review DEQ has determined that the preliminary numeric RAOs (i.e. Preliminary Remedial Goals) identified by DEQ are appropriate values to serve as target levels during the development, analysis and selection of cleanup alternatives. DEQ is open to the development of action levels in remedial design that evaluate the potential for significant attenuation but not as part of the FS process. The alternatives developed in the feasibility study report and the proposed remedy selected in the feasibility report must be based on DEQ's directed modification.</p> <p>DEQ does not agree the hardness observed in upland groundwater is appropriate for calculating screening levels in the FS for transition zone or surface water receptors.</p>
2	General Comment	FS Work Plan states that GW action levels in the FS will reflect attenuation to meet the AWQC. DEQ notes that the same contaminants were detected in off-shore pore water as in upland groundwater. DEQ assumes little attenuation will occur before transition zone, and GW concentrations should be screened against AWQC.	<p>Comment noted. LSS will screen hot spots using the AWQC and assuming that constituents in groundwater are transported unattenuated to the transition zone. For the purpose of evaluating hot spots, LSS has also accepted DEQ's supposition that the concentrations in transition zone are representative of possible ecological exposures in surface water. LSS does not agree that these assumptions are appropriate for determining remedial action levels in the FS.</p> <p>LSS will work with the DEQ to assess empirical (sampling) or theoretical (calculation and modeling) methods to compare chemical concentrations in the transition zone to concentrations in upland groundwater by area of the site (e.g., Lots 1, 2 vs Lot 3, 4). A statistically based sampling and analysis or a theoretical analysis must be incorporated into the FS to develop risk-based remedial action levels. In addition to screening concentrations in comparison to AWQC, LSS will also screen to more appropriate values such as MCLs or appropriate risk-based values.</p> <p>LSS will propose sampling or analysis to demonstrate attenuation. The methods will be outlined in the FS Work Plan for implementation in the FS or as part of the remedial design/remedial action (RD/RA).</p>	<p>As documented in our review DEQ determined this assumption is appropriate for evaluating alternatives in the FS and directs LSS to use this assumption when evaluating alternatives in the FS.</p> <p>DEQ is open to reviewing a remedial design work plan that presents a strategy to evaluate the potential for significant attenuation as part of remedy design but not as part of the FS process.</p>
3	general comment	Screening groundwater to identify preliminary groundwater hot spots must follow the indicated hierarchy. Update the preliminary groundwater hot spot figures accordingly.	The Revised FS Work Plan screens data to hot spot criteria in accordance with the hierarchy in accordance with DEQ specific comments.	LSS did not implement the hierarchy correctly. Specific examples are presented in DEQ's attached review comments.

4	general comment	Numerical remedial action objectives (RAOs) & hot spot levels must be based on most recent RBDM values updated Nov. 1, 2015	The Revised FS Work Plan screens data to hot spot criteria in accordance with the DEQ-mandated hierarchy. LSS used DEQ and EPA aquatic life criteria that were current at the time of the draft FS Work Plan. There have been updates to some Risk-Based Decision Making (RBDM) values since the FS Work Plan document was submitted in June 2012. Numerical RAOs & hot spot levels are based on the most recent RBDM values updated 1 November 2015. Tables and figures in the Revised FS Work Plan are updated accordingly.	<p>RBCM values were updated by DEQ in May 2018. Current values must be used.</p> <p>DEQ has clarified the definition of chemical classes to include such chemicals as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans (dioxins/furans), chlordanes and total petroleum hydrocarbons (TPH). These chemical classes should be evaluated as a single hazardous substance for determining risk and potential hot spots. The acceptable cancer risk level for individual hazardous substances of one-in-one-million and non-cancer hazard quotient of one applies to each chemical class, and potential hot spot determinations will be made accordingly.</p> <p>Carcinogenic PAHs should be evaluated as summed benzo[a]pyrene equivalents. Dioxins/furans should be evaluated as the sum of 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents. PCBs should be evaluated as total PCBs, either derived from congeners or aroclors. Similarly, total petroleum hydrocarbons and chlordanes should be evaluated as totals. This approach for evaluating chemical classes replaces Section 3.3.5 of DEQ's October 2010 Human Health Risk Assessment Guidance.</p>
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DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
5	General Comment	The FS WP must use the 2009/2010 Rhone Poulenc (RP) data, dioxin/furan data (see below), field observation data, and early site investigation data.	Hot spot screening in the Revised FS Work Plan uses RP 2009/2010 dioxin/furan data from monitoring wells. The hot spot screening uses 2009/2010 RP data collected from a properly installed and developed monitoring well. The hot spot screening does not use 2009/2010 RP data collected from temporary Geoprobe points. The Geoprobe data were not used for delineation due to poor sample quality.	LSS did not use the 2009/2010 RP data as directed. The Work Plan did not use all of the Rhone-Poulenc data collected in 2009. Monitoring wells on Lot's 1 and 2 were sampled by Rhone-Poulenc in August 2009 and in January 2010. The Work Plan appears to have used the 2010 data but not the 2009 data.
General Comments; Human Health Risk Assessment (HHRA)				DEQ's Response
1	General Comment	The site-specific risk based values developed in the approved HHRA are not preliminary and must be carried through the FS.	LSS will screen hot spots using the AWQC and assuming that constituents in groundwater are transported unattenuated to the transition zone. For the purpose of evaluating hot spots, LSS has also accepted DEQ's supposition that the concentrations in transition zone are representative of possible ecological exposures in surface water. LSS does not agree that these assumptions are appropriate for determining remedial action objectives (RAOs) and action levels in the FS. LSS will also screen data to more appropriate values such as MCLs or appropriate risk-based values. As agreed by the DEQ in a 24 August 2017 meeting, the hot spots identified in the FS and Revised FS Work Plan may be refined based on pre-design investigation.	LSS's response is not relevant to DEQ's comment. The site-specific risk based values developed in the approved HHRA are based on a carcinogenic Risk >1x10-6 consistent with Oregon Law. The FS WP referred to the site-specific risk based values developed in the approved HHRA as preliminary. These values are not preliminary but final. Remedial actions levels must be based on a carcinogenic Risk >1x10-6 consistent with Oregon Law.
2	General Comment	FS must evaluate risk as defined in the HHRA and not risk post interim remedies. Interim remedies must be carried into the FS in accordance with balancing factors.	Comment noted. The FS will evaluate risk as defined in the HHRA and not risk post interim remedies. Interim remedies will be carried into the FS in accordance with balancing factors. Work performed before 2008 will be incorporated into the FS as "existing" site conditions. See response to Hot Spots General Comment 5.	It is unclear what work LSS is LSS is referring to in this comment. It is appropriate to exclude soil removed as part of interim removal actions that have sufficient confirmation samples, however no other "work" may be incorporated into the FS as "existing" site conditions.
General Comment; Contaminants of Concern				DEQ's Response
1	General Comment	Reference to COPCs must be revised to COCs per DEQ definitions	Comment noted. The reference to chemicals of potential concern (COPCs) is revised to contaminants of concern (COCs) per OAR 340-122- 0115(15).	Response acceptable
Specific Comments				DEQ's Response
1	3.1.2 Old Caustic Tank Farm, p. 16	FS Work Plan must delineate area of elevated pH in groundwater. FS must consider remedial alternatives for GW with high pH discharging to River above pH 8.5 and dissolution of metals and discharge to River at concentrations above acceptable risk or background levels.	Section 3.1.2 notes the implications for dissolution of aquifer metals into groundwater. The pH evaluation in the FS will use data before construction of the groundwater barrier wall. See response to Hot Spots General Comment 5.	pH maps do not show pH plume extending to the river without explanation and Hot Spots General Comment 5 is not applicable to this comment.
2	3.1.4 Ammonia Plant, p. 15	Evaluation of remedial alternatives for the ammonia plume is not required for the FS, however "additional investigation" is needed to demonstrate that the (Arkema) Ammonia Plant did not contribute to the ammonia plume. Additional investigation is required to apply the contaminated aquifer policy.	Comment noted. DEQ is not requiring evaluation of remedial alternatives for the ammonia plume. The text states that additional investigation may be required to apply DEQ's contaminated aquifer policy in accordance with previous statements.	Response acceptable
3	3.2.3 Site-Wide Groundwater Sampling, p.19 - 20	The northern extent of DDx and chloride in GW are not bounded by the GW SCM. The FS Work Plan must state the northern extent of Arkema DDx, chloride and other site-related COCs in groundwater are not bounded by the groundwater SCM. The FS must evaluate remedial alternatives for contaminants above a WQC (water quality criteria) or risk-based values outside of the capture zone of the containment system.	Given the many low level detections of DDx (sum total of DDD, DDE, and DDT) in monitoring wells across the site, it may not be feasible to delineate the northern or western (upgradient) extent of DDx to the low AWQC. Any detection of DDx is above the hot spot criteria. The Revised FS Work Plan states that the northern extent of Arkema DDx, chloride, and other site-related COCs in groundwater may not be bounded by the hydraulic influence of the groundwater source control measure (SCM).	Response acceptable
4	3.2.3 Site-Wide Groundwater Sampling, p.19 - 20	FS Work Plan must identify the data to be included in the FS. The FS Report is not an appropriate place for a new evaluation regarding nature and extent.	See response to HHRA General Comment 1. LSS assumes that there may not be additional groundwater monitoring performed by LSS before the FS. The existing data are over 8 years old. LSS will propose a new round of groundwater monitoring. The additional data will be incorporated into subsequent pre-design submittals, which may change delineation of hot spots from the Revised FS Work Plan, as agreed by the DEQ in a 24 August 2017 meeting.	See DEQ's response to Hot Spots General Comment 1.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
5	3.4 Soil IRAMs, p. 22, Last paragraph	The FS Work Plan should note that the default hot spot criterion is based on the human health risk (occupational exposure) defined before the construction of the interim engineering controls.	The requested clarification is made.	Response acceptable
6	3.6.3.1 EE/CA RAA Riverbank Alternatives Evaluation.	DEQ and LSS agreed to an assumed approach for the riverbank in lieu of developing site-specific terrestrial ecological risk values for dioxins/furans. Present this agreed approach in the FS Work Plan.	The Revised FS Work Plan incorporates the agreed approach. LSS notes that characterization of the riverbank will require additional soil sampling.	Response acceptable. DEQ has provided additional text for clarity.
7	4.1.1 Lots 1 and 2, p. 34	Paragraph stating that, "Estimated cancer risks associated with arsenic in soil are likely overestimates..." is not consistent with the RA or DEQ or EPA risk guidance and must be removed.	The identified statement is removed.	Response acceptable
8	4.1.2 Lots 3 and 4, page 34	The presence of dioxins and furans (D/F) in catch- basin solids indicates the potential presence of D/F in site soil. Section 4.1.2 and Table 4-1 of the FS Work Plan must note potential for D/F in surface soil, and the FS must present alternatives to manage the risk. DEQ's 10/23/08 letter documents DEQ conclusion.	DEQ's 21 July 2010 comment letter on Data Gaps Investigation report acknowledged that debris associated with power pole demolition may have contributed to the presence of D/F in catch basin sediment as wood debris was noted in 5 of the 11 catch basins tested for D/F. DEQ also acknowledges that the conceptual site model needs to allow for the possible contribution of off-site sources to site soils and catch basin sediment. Section 4.1.2 and Table 4-1 of the FS Work Plan note potential for D/F in surface soil in Lots 3 and 4, as indicated in the results of the Data Gaps Investigation. The FS will present alternatives to manage the risk.	Response acceptable, however the modifications made to the text are not consistent with DEQ direction. DEQ has modified the Work Plan to address this error.
9	4.1.3 Riverbank	FS Work Plan inaccurately states that adverse health effects are not expected due to PCE. The RME for indoor workers was reported to be greater than 10 ⁻⁶ , indicating unacceptable risk. The FS WP must be revised to state this result and the FS must evaluate remedial alternatives for PCE in riverbank.	The text referenced in the comment inadvertently discusses subsurface soil on Lots 3 and 4, not the riverbank. The cited text should be in Section 4.1.2. The cited text is revised/moved to Section 4.1.2. Comment noted. Table 4-1 is updated to include PCE as a COC for the indoor work receptor and differentiates between upland soil and riverbank soil.	Response acceptable.
10	4.1.3 Riverbank	Fourth paragraph incorrectly concludes that remedial action is not needed to address riverbank contamination. Paragraph must be deleted and the FS must evaluate remedial alternatives for the riverbank.	The text referenced in the comment inadvertently discusses subsurface soil on Lots 3 and 4, not the riverbank. The cited text should be in Section 4.1.2.	Response acceptable
11	4.2 Level 2 Screening Level ERA p. 36 - 38	Update section to reflect the agreements reached for the riverbank per September 3, 2013 email chain from Matt McClincy to David Livermore. See specific comment 6	The requested clarification is made. See response to specific comment 6.	Response acceptable. DEQ has provided additional text for clarity.
12	4.3 Hot Spot Evaluation, p. 38	Hot spot soil figures in Appendix A must include contour line for risk concentration. E.g., 4,4 DDT, contour line at 8.5 mg/kg for outdoor worker exposure.	Soil hot spot figures in Appendix A will include a contour line for risk concentrations. Edits to text, tables, and figures related to hot spots (DEQ specific comments 12 through 56) appear in Appendix A.	Response acceptable
13	4.3 Hot Spot Evaluation, p. 38	Where modifications (e.g., based on CSM or IRMs) were made to the iso-concentration contours the original software generated plots for comparison to the modified plots must also be provided in revised FS Work Plan.	A 28 August 2017 email from Matt McClincy to Brendan Robinson withdrew the request.	Substantial modifications to the iso-concentrations contours outside of DEQ's requested modifications. DEQ will provide comments on the preliminary hot spot evaluation separately.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
14	4.3 Hot Spot Evaluation, p. 38	The soil within the footprint of the overflow trench and DDT Manufacture Residue Pond must be identified as high concentration and/or highly mobile hot spots. Confirmation samples were not collected from the bottom or sidewalls of the excavation. The southern half of the overflow trench excavation and base of the pond excavation likely exceed high concentration hot spot levels as pink soils were observed to a depth of 8 feet in boring RB- SB31 which is located in the approximate midpoint of the trench.	The soil within the footprint of the overflow trench and DDT Manufacture Residue Pond is identified as high concentration and/or highly mobile hot spots.	It is unclear how this response was integrated into the Revised FS WP. The areas are not included in the hot spot areas depicted in the Appendix A figures. It is not possible to verify whether or not these areas were included in the area and volume estimates presented in the Revised FS WP due to the lack of documentation on how those estimates were calculated. DEQ will provide comments on the preliminary hot spot evaluation separately.
15	Section 4.3.1 Preliminary Highly Concentrated Hot Spots	The reference to Table 3-3 should be Table 4-3.	The table reference is corrected.	Response acceptable
16	4.3.1 Preliminary Highly Concentrated Hot Spots	DEQ updated its RBDM table on Nov. 1, 2015 the new values must be used in the Final FS Work Plan	See general comment 4. The new RBDM values are used in the Revised FS Work Plan.	See response to Hot Spot General Comment 4.
17	4.3.1 Preliminary Highly Concentrated Hot Spots	Data presented in the hot spot summary figures (Appendix A) does not appear to have included soil data from the Phase 1 and Phase 2 soil characterization efforts (TP and GA-SB data points). The hot spot evaluations must be updated with this data.	Data from the Phase 1 and Phase 2 soil characterization (TP and GA-SB data points) are included in the hot spot evaluation, pending an evaluation of data quality.	Response acceptable
18	4.3.1.1 Human Exposure Routes, Page 39	Shallow monitoring well MWA- 63 was constructed after the HHRA. Chloroform detected in MWA-63 (9,800 µg/L) exceeds DEQ occupational RBC for groundwater vapor intrusion into buildings (1,600µg/L). FS Work Plan must summarize the unacceptable risk associated with this well location.	The Revised FS Work Plan summarizes the unacceptable risk to include indoor air vapor intrusion with this well location.	Response acceptable, but in the wrong section of the report.
19	4.3.1.1 Human Exposure Routes, P 40	DEQ Hot Spot Guidance does not include screening individual compounds. If the contaminant is present above an RBDM screening criteria but below a high concentration hot spot, it does not have to be evaluated in the FS as a hot spot.	Comment noted. The identified text is eliminated.	Response acceptable but DEQ notes the paraphrased comment does not include DEQ's main point. The original comment stated "The referenced section of the DEQ Hot Spot Guidance on exposure pathways does not discuss screening individual compounds. Consequently, this is not a basis for not carrying a contaminant into the feasibility study if it is present at concentrations in excess of the high concentration hot spot levels. If the contaminant is present above an RBDM screening criteria but below a high concentration hot spot, it does not have to be evaluated in the FS." Based on LSS's response DEQ assumes LSS hot spot screening included all detected COIs not just those identified as COCs.
20	4.3.1.1 Human Exposure Routes, fourth paragraph, page 40	While remedial design work will be needed to refine soil hot spot boundaries, the soil hot spot for DDT identified in Figures A-2A and A-3A in the vicinity of IB-43, IB-46 and US-01, in particular, likely extend further riverward and should be considered a data gap. FS Work Plan must clearly state that the DDT soil hot spot likely extents further riverward and will be address as a data gap in remedial design. Address in text and figures.	The requested clarifications are added.	LSS address this comment in text but not in the associated figures. It is unclear how it was handled in the hot spot area and volume estimates. DEQ will provide comments on the preliminary hot spot evaluation separately.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
21	4.3.1.1 Human Exposure Routes, fifth paragraph, p 40	See HHRA General Comment 1. The site-specific risk based values developed in the approved HHRA are not preliminary and must be carried through the FS. Delete the paragraph.	The indicated paragraph is removed from the report. See response to HHRA General Comment 1. As agreed by the DEQ in a 24 August 2017 meeting and as acknowledged in DEQ Specific Comment 20, LSS assumes that the hot spots identified in the Revised FS Work Plan may be refined based on pre-design investigation. Pre-design investigations performed between the finalization of the risk assessments and the preparation of the FS will be incorporated into the alternatives evaluation in the FS, including the effects of these actions on residual risk to receptors. A general statement will be added.	LSS deletion of the paragraph addresses DEQ's comment. However, see DEQ's response to Hot Spots General Comment 1 in regards to incorporating new data into the FS. DEQ notes the risk assessments have already been finalized and approved/modified by DEQ and DEQ will not approve any pre-design work prior to completion of the FS.
22	4.3.1.1 Human Exposure Routes, first paragraph, p 41	References General Comment 2. DEQ assumes little attenuation will occur before transition zone and GW concentrations should be screened against AWQC. The paragraph must be deleted.	The indicated paragraph is removed from the report. Interim remedial measure (IRM) work performed between the finalization of the risk assessments and the preparation of the FS will be incorporated into the alternatives evaluation in the FS, including the effects of these actions on residual risk to receptors.	LSS deletion of the paragraph addresses DEQ's comment. See General comment HHRA 2.
23	4.3.1.1 Human Exposure Routes, last paragraph, p 41	2,3,7,8-TCDD at sample location B-124 is a high concentration soil hot spot and must be retained. The revised FS Work Plan must identify the preliminary boundary of this hot spot area based on the conceptual site model for the cell maintenance at this location. Delete the last half of the paragraph that starts with "As discussed in Section 4.1"	The Revised FS Work Plan identifies the preliminary boundary of the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) hot spot area based on the conceptual site model for the cell maintenance at this location. IRM work performed between the finalization of the risk assessments and the preparation of the FS will be incorporated into the alternatives evaluation in the FS, including the effects of these actions on residual risk to receptors.	LSS deletion of the paragraph addresses DEQ's comment. See General comment HHRA 2.
24	4.3.2 Preliminary Groundwater Hot spots, p 44	DEQ directed use of AWQC as SLVs for preliminary groundwater hot spots and use of the lower of the DEQ Table 33C (currently Table 31) or ORNL values for contaminants that do not have chronic AWQC. The FS Work Plan and the Revised HSE must be revised to include the lower of the Table 31 and ORNL values for contaminants that do not have chronic AWQC.	The FS Work Plan is revised to include the lower of the Table 31 and Oak Ridge National Laboratory (ORNL) values for contaminants that do not have chronic AWQC.	LSS did not implement the directed changes.
25	"	The FS Work Plan and Hot Spot Evaluation must be revised using the current AWQC.	See responses to Hot Spot General Comments 3 and 4.	See DEQ's response to Hot Spots General Comment 3 and 4.
26	Section 4.3.2 Preliminary Groundwater Hot Spots, p 44	For the purposes of the FS, transition zone porewater is defined as interstitial water of bulk sediment within the biologically active zone. EPA in the 2016 Portland Harbor ROD defines the biologically active zone as less than 38 cm below mudline. This definition of the porewater must be incorporated in the FS Work Plan.	See responses to Hot Spot General Comments 1 and 2. EPA originally defined the transition zone as 0 to 10 centimeters and the change to 0 to 38 centimeters is not justified. If proposed, sampling and analysis will assume that the groundwater-surface water transition zone occurs in a layer of sediment 30-centimeters thick unless literature review or site-specific data indicate that a different transition zone thickness is more appropriate for the analysis.	LSS's response appears to be constant with EPA's current direction.
27	"	DEQ requires the use the transition zone porewater as the point-of-compliance for the identification of preliminary groundwater hot spots and the evaluation of remedial alternatives in the FS.	See response to Hot Spots General Comment 1. The definition of the transition zone is incorporated in the Revised FS Work Plan.	See DEQ's response to Hot Spot General Comments 1.
28	"	Hot Spots General Comment 1. DEQ concludes that the POC for AWQC and determination of GW hot spots is the transition zone porewater.	See response to Hot Spots General Comment 1. The definition of the transition zone is incorporated in the Revised FS Work Plan.	See DEQ's response to Hot Spot General Comments 1.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
29	"	Hot Spots General Comment 2. DEQ assumes little attenuation will occur before transition zone and GW concentrations should be screened against AWQC.	See response to Hot Spots General Comment 2.	See DEQ's response to Hot Spot General Comments 2.
30	"	DEQ required LSS to use the 2009/2010 groundwater data collected on the site by Rhone Poulenc (reference 7) which the work plan and addendum did not use as requested. DEQ requires LSS to use the Rhone Poulenc data as initially requested to identify preliminary groundwater hot spots in the revised FS Work Plan.	See response to Hot Spot General Comment 5.	See DEQ's response to Hot Spot General Comment 5. LSS did not use the 2009/2010 RP data as directed.
31	"	DEQ overlooked requirement to use 2006 D/F data from the Acid Plant and Chlorate monitoring wells. DEQ requires that the August 2006 D/F GW data be included in the revised groundwater screening. DEQ provided the screening criteria and associated supporting calculations in Attachment 4.	The revised groundwater screening will [be] use the August 2006 D/F groundwater data.	Response acceptable. However because of how LSS presented and documented the screening DEQ cannot tell what groundwater data was used. The report only presents a summary of the data and does not document the date of the sample or footnote how the value was selected. Further, the text gives conflicting statements on what was used.
32	Section 4.3.2 Preliminary Groundwater Hot Spots, p 44	DEQ disagrees that SCM performance data is necessary before finalizing the upland FS. DEQ does not approve delaying completion of the upland FS until the performance of the groundwater source control measure has been evaluated.	LSS will continue with the FS while the groundwater SCM is being evaluated under the PMP and associated submittals. IRM work performed after the risk assessments will be incorporated into the alternatives evaluation in the FS, including the effects of these actions on residual risk to receptors. The subject paragraph is deleted.	LSS deletion of the paragraph addresses DEQ's comment. See General comment HHRA 2.
33	4.3.2 Preliminary Groundwater Hot Spots, p 45	DEQ agrees that it is likely that the Groundwater SCM will be a component of the upland remedial measure. However, the FS must evaluate remedial actions utilizing treatment to restore the beneficial uses of site groundwater. Successful groundwater treatment would not require the long-term reliance on engineering, such as the Groundwater SCM.	The FS will evaluate remedial actions, including a combination of treatment and engineering controls. The subject paragraph is deleted.	LSS deletion of the paragraph addresses DEQ's comment.
34	4.3.2.1 Metals, p 45	Figures A-9 through A-12 use 190 µg/L as the preliminary hot spot criteria for arsenic. The EPA National Recommended WQC for human consumption of organisms (0.14 µg/L) or a background groundwater values should be used.	The regional arsenic background is 3 - 5 µg/L (personal communication DEQ and USGS). 2.1 µg/L is the AWQC. Figures A-9 through A-12 will use 2.1 µg/L as the hot spot criterion for arsenic.	Response acceptable
35	"	Data from 2009/2010 RP-14-26 and RP-14-39 down gradient of the brine sludge pond had arsenic concentrations ranging from 158 and 183 µg/L. This data must be incorporated in the revised FS Work Plan and hot spot evaluation. See comment 30 re 2009/10 RP data. These data must be added.	See response to Hot Spot General Comment 5. See response to Specific Comment 34.	LSS did not implement the directed changes. LSS's response to Hot Spot General Comment 5 does not address this issue.
36	"	Groundwater pH values must be presented on figures to support the relationship between arsenic and pH discussed in this section. DEQ expects that arsenic will be a COC that requires evaluation in the FS, contrary to the conclusion reached in Section 4.3.2.1.	The Revised FS Work Plan presents pH data along with arsenic data, and re-evaluates the arsenic hot spot.	Response acceptable

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
37	4.3.2.2 Chromium, p 46	Figures A-14 through A-17. Hexavalent chromium (Cr+6) was quantified, we are not aware that Cr+3 was quantified in groundwater. Given this, Section 4.3.2.2 and the associated figures must be revised to discuss total chromium, or Cr+3 value should be calculated by subtracting the Cr+6 concentrations from the total Cr data when the two are available.	The text and the figures will reference total chrome.	Response acceptable
38	4.3.2.5 Perchlorate, p 48	DEQ's derived human health criteria for perchlorate (1,800 µg/L) must be used instead of the AWQC aquatic life value equivalent derived by DEQ of 9,300 µg/L to identify preliminary groundwater hot spots.	The Revised FS Work Plan updates the groundwater hot spot for perchlorate based on the AWCQ of 1,800 µg/L.	Response acceptable
39	4.3.2.6, Volatile Organics, p 48	It appears LSS used the chloroform value from DEQ's Table 31: Aquatic Life Water Quality Guidance Values for Toxic Pollutants (1,240 µg/L) instead of the ORNL value of 28 µg/L. LSS must review and confirm all the identified hot spot criteria are correct and consistent with DEQ's hot spot screening direction.	Hot spot tables and figures for chloroform are revised using the value of 1,100 µg/L for chloroform, which is the lowest of the promulgated criteria, as specified in the DEQ hierarchy.	LSS did not implement the directed changes.
40	"	2nd paragraph states that VOC hot spots are within the capture zone of the GW SCM. DEQ notes that this is probably not the case for chloroform. 2009 RP RI data indicate that the preliminary chloroform hot spot may extend north of the Lot 2 and Lot 3 boundary. Language should be added to the FS Work Plan indicating the uncertainty associated with nature and extent of this plume.	Language is added to the Revised FS Work Plan indicating the extent of the VOC plumes, including chloroform.	Response acceptable
41	4.3.2.6 Volatile Organics, p 48	Figures A-38 through A-41 must use the Oregon Human Health Organism Only value of 0.33 µg/L for tetrachloroethene. The FS Work Plan must identify the uncertainty associated with the nature and extent of this plume.	Table 4-4 and applicable figures are updated to use the Oregon Human Health Organism Only value of 0.33 µg/L for tetrachloroethene. The Revised FS Work Plan identifies the uncertainty associated with the extent of this plume. See response to Hot Spot General Comment 3.	LSS used the correct hot spot criteria for tetrachloroethene but did not identify the uncertainty associated with the extent of this plume. DEQ will provide comments on the preliminary hot spot evaluation separately.
42	"	Figures A-42 through A-45 must be revised using the ORNL value of 14 µg/L for 1,2-dichlorobenzene	Table 4-4 and applicable figures are updated to use 130 µg/L as the screening criteria for 1,2-dichlorobenzene, which is the lowest of the promulgated criteria, as specified in the DEQ hierarchy. The ORNL value of 14 µg/L for 1,2-dichlorobenzene is included in Table 4-4.	LSS did not implement the directed changes. DEQ will provide comments on the preliminary hot spot evaluation separately.
43	Section 4.3.2.8, Pesticides, p 49, 50	Figures A-46 through A-49 must be revised to reflect the EPA NRWQC Human Health Organism Only value of 0.0000059 µg/L for heptachlor.	Table 4-4 and applicable figures are revised to reflect the EPA National Recommended Water Quality Criteria (NRWQC) Human Health Organism Only value of 0.0000059 µg/L for heptachlor.	Response acceptable
44	"	Figures A-54 through A-55 must be revised to reflect the Oregon Human Health Organism Only AWQC value of 0.000081 µg/L for chlordane.	Table 4-4 and applicable figures are revised to reflect the Oregon Human Health Organism Only AWQC value of 0.000081 µg/L for chlordane.	Response acceptable
45	"	Figures A-56 through A-59 should be revised to reflect the Oregon Human Health Organism Only AWQC value of 0.000022 µg/L for DDT 4,4'.	Table 4-4 and applicable figures are revised to reflect the Oregon Human Health Organism Only AWQC value of 0.000022 µg/L for DDT 4,4'.	Response acceptable

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
46	"	The discussion of possible DDT sources must include the DDT manufacturing waste disposal trench on Lot 1.	The discussion of possible DDT sources includes DDT manufacturing waste disposal trench on Lot 1. See specific comment 14.	DEQ will provide comments on the preliminary hot spot evaluation separately.
47	"	DEQ does not agree that significant degradation of the existing 4,4'-DDT levels in groundwater are likely to occur. The last paragraph in this section must be deleted to be consistent with current site conditions and DEQ's previous direction.	LSS will propose sampling or analysis to demonstrate attenuation. The methods are outlined in the Revised FS Work Plan for implementation in the FS or remedial design. A technical memorandum will detail the methods. See response to General Hot Spot Comment 2.	See DEQ's response to Hot Spot General Comments 2.
48	Section 4.3.3 Preliminary Highly Mobile Hot Spots, p.51	The work plan needs to clarify that the FS will evaluate a range of remedial options for stormwater and erodible surface soils, including the existing interim measures.	The Revised FS Work Plan states that the FS will evaluate a range of remedial options for stormwater and erodible surface soils, including the existing interim measures.	Response acceptable
49	Section 4.3.3 Preliminary Highly Mobile Hot Spots, P. 54, Table 4-4	The report does not clearly present how the leaching to groundwater preliminary hot spot levels were calculated. Table 4-4 must be modified to shown the formula used to calculate the hot spot criteria.	The Excel file for Table 4-4 is modified to show the method used to calculate the leaching to groundwater criteria.	LSS did not implement the directed changes. The Excel file for Table 4-4 was not submitted to DEQ.
50	"	The selected hot spot criteria column is not filled in properly. Table 4-4 must be revised to clearly show the selected hot spot criteria for each COC.	Table 4-4 is reformatted to show the selected hot spot for each COC.	Response acceptable
51	Section 4.3.3 Preliminary Highly Mobile Hot Spots, p. 52, 53	DEQ will not approve the development of alternative model-based criteria (for leaching to groundwater assessment of highly mobile hot spot) prior to conducting the evaluation of alternative in the FS.	The Revised FS Work Plan and FS will use screening methods to assess highly mobile hot spots. Refinement of highly mobile hot spots may occur during alternative development and the remedial design.	DEQ will not approve the development of alternative model-based criteria (for leaching to groundwater assessment of highly mobile hot spot) prior to completion of the FS.
52	Section 4.3.3 Preliminary Highly Mobile Hot Spots, p. 50 to 54.	The leaching to groundwater highly mobile hot spots on Figures A-60 through A-67A must be compared to the shallow/intermediate groundwater zone hot spots figures as a line of evidence to support the evaluation of whether the soil identified as a highly mobile hot spot is reasonable.	The Revised FS Work Plan includes a qualitative comparison of highly mobile soil hot spots to hot spots in shallow/intermediate groundwater zones as a line of evidence to support the evaluation.	DEQ will provide comments on the preliminary hot spot evaluation separately.
53	Section 4.3.3.1 Chromium, p. 54	The selection of a soil pH of 7.0 as conservative in the estimate of establishing leaching criteria for chromium must be supported.	Chromate predominates at about pH 7.5. Chromate salts have low solubility. The rationale for using pH 7 for estimating soil chromium concentrations is presented.	DEQ will provide comments on the preliminary hot spot evaluation separately.
54	Section 4.3.3.4 Chloroform, p. 55	The estimated source area of the Lot 3 shallow groundwater chloroform plume must be shown on Figure A-62 and explained as a remedial design data gap in Section 4.3.3.4.	Appendix A, Section 1.3.4 states that the sources of the chloroform detection in groundwater are uncertain, but are likely associated with the breakdown of chloral.	LSS did not implement the directed changes. The estimated area was not shown.
55	Section 4.3.3.8 Chlordane, page 56	DEQ does not agree that significant degradation of the existing chlordane levels in groundwater are likely. Third paragraph on page 56 must be deleted	LSS will propose sampling or analysis to demonstrate attenuation. The methods will be developed in a technical memorandum and implemented as part of the RD/RA. See response to General Hot Spot Comment 2.	LSS deletion of the paragraph addresses DEQ's comment. See DEQ's response to General Hot Spot Comment 2.
56	Section 4.3.3.9 DDT, p. 57	DEQ does not agree that significant degradation of the existing 4,4'-DDT levels in groundwater are likely to occur. Preliminary groundwater hot spots need to be carried into the feasibility study evaluation. Refinement of highly mobile hot spots can occur during remedial design by conducting synthetic precipitation leaching testing on representative soil samples.	LSS will propose sampling or analysis to demonstrate attenuation. The methods will be developed in a technical memorandum and implemented as part of the RD/RA. See response to General Hot Spot Comment 2.	Response acceptable. See DEQ's response to General Hot Spot Comment 2.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
57	Section 5.2 Impacted Media, p. 59	Dioxins must be added to the list of contaminants that have impacted site media in the first sentence of the second paragraph on page 59.	Dioxins are added to the list of contaminants that have impacted site media. However, based on LSS's understanding of the chlor-alkali process, furans were generated. Dioxins are included, but the source of dioxins is assumed to be background or from off-site; the site itself does not appear to be a source of dioxins.	Modifications made to the text are not consistent with DEQ direction.
58	Section 5.2 Impacted Media, p. 59	The last portion of the last sentence on page 59 that reads "and, will further refine the preliminary hot spots of contamination areas or volumes of media that require remedial action" must be deleted.	The paragraph is modified as indicated. See response to General Hot Spot Comments 1 and 2 and Specific Comment 21.	Response acceptable. See DEQ's response to General Hot Spot Comment 1 and 2.
59	Section 5.2.2 Areas or Volumes p. 60.	The last sentence of paragraph one and the first sentence of paragraph three on page 60 must be deleted.	The paragraph is modified as indicated. See response to General Hot Spot Comments 1 and 2 and Specific Comment 21. LSS will work with DEQ to develop methods to calculate areas and volumes in the remedial design. See new section 5.2.3	Response acceptable. See DEQ's response to General Hot Spot Comment 1 and 2.
60	Section 5.2.2 Estimated Preliminary Hot Spot Volumes, p. 60	The last sentence of this section must be deleted. See previous comments on the development of site- specific groundwater and leaching to groundwater hot spots.	The paragraph is modified as indicated. See response to General Hot Spot Comments 1 and 2 and Specific Comment 21.	Response acceptable. See DEQ's response to General Hot Spot Comment 1 and 2.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
61	Section 5.3 Remedial Action Objectives, p. 60	<p>DEQ listed RAOs:</p> <p>RAO 1 -Reduce upland human health risks to acceptable risk-based levels from ingestion, inhalation and direct contact with soil under trespasser, indoor and outdoor worker, outdoor after redevelopment, and construction worker scenarios.</p> <p>RAO 2 - Reduce riverbank terrestrial ecological risk to acceptable risk-based levels from direct and indirect exposure to soil.</p> <p>RAO 3 - Prevent the potential migration and erosion of COCs in surface soil and riverbank soil to accumulate in Willamette River sediment above acceptable risk-based levels.</p> <p>RAO 4 -Treat or remove soil hot spots to the extent feasible based on remedy selection balancing factors.</p> <p>RAO 5 -Prevent and/or reduce the migration of groundwater COCs to the Willamette River above acceptable risk-based levels for surface water receptors.</p> <p>RAO 6 -Treat or remove groundwater hot spots to the extent feasible based on remedy selection balancing factors.</p> <p>RAO 7 -Reduce the potential for DNAPL to act as a continuing source of COCs in groundwater.</p> <p>RAO 8 -Treat or remove DNAPL hot spots to the extent feasible based on remedy selection balancing factors.</p> <p>RAO 9 -Reduce the migration of COCs in stormwater to the Willamette River above acceptable risk-based levels for surface water receptors.</p> <p>RAO 10 -Reduce the migration of COCs in stormwater to the Willamette River to prevent accumulation of COCs in river sediment above risk-based levels.</p>	The RAOs are updated as requested.	Response acceptable.
62	Section 5.3 Identification of Remedial Action Objectives, p. 61	The FS Work Plan must identify a numeric value for RAO 9 above (i.e., human health ambient water quality criteria organism consumption). Based on the previous sediment recontamination evaluation conducted by LSS, this value should also be protective for RAO 10.	The FS will identify a numeric value for DEQ RAO 9.	LSS did not implement the directed changes.
63	Section 5.3 Identification of Remedial Action Objectives, p. 61	The FS Work Plan must indicate that alternatives will be developed for RAOs 9 and 10 including the existing interim system. It is anticipated that these will include a site-wide cap that eliminates stormwater contact with contaminated soils and associated institutional controls.	The Revised FS Work Plan indicates that alternatives will be developed for RAOs 9 and 10 including the existing interim system. Likely alternatives will include a site-wide cap that eliminates stormwater contact with contaminated soils and associated institutional controls.	Response acceptable.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
64	Section 5.3.1 Preliminary Numerical Remedial Action Objectives, p. 61	Use of a target risk range 10-4 to 10-6 is consistent with CERCLA and the Portland Harbor Human Health Risk Assessment. However, DEQ requires the evaluation to use a risk range consistent with Oregon Administrative Rules OAR 340-122-0115 for human exposure. LSS must use the risk values from either the DEQ approved upland human health risk assessment or the DEQ Risk-Based Decision Making Table11 to identify numerical remedial action objectives.	The FS will use the risk values from either the DEQ approved upland HHRA or DEQ RBDM.	LSS did not implement the directed changes. Section 5.3.1 still states "In addition, for the purpose of evaluating alternatives for acceptable residual risk to human receptors, LSS intends to apply a target risk range of 1x10-4 to 1x10-6 in accordance with CERCLA and consistent with the Portland Harbor HHRA (Kennedy/Jenks Consultants 2013). The COPCs identified in the HHRA that exceeded this target risk range are summarized in Table 4-1."
65	Section 5.3.1 Preliminary Numerical Remedial Action Objectives, p. 62	DEQ has not used the mass reduction or technically practicable terms to describe the objectives of the stormwater source control measure. The objective of the stormwater treatment system design is to meet the effluent goals thereby helping to ensure that the discharge does not cause or contribute to the exceedance of applicable ambient water quality standards. The terms mass reduction and technically practicable must be removed from this section.	The cited paragraph refers to the design objectives of the SCM. The Revised FS Work Plan cites the effluent goals of the stormwater SCM. The FS will identify possible technical impracticability related to future treatment, if applicable. The terms "mass reduction" and "technically practicable" are removed from the discussion of the SCM.	LSS did not implement the directed changes.
66	"	The stormwater treatment system is an interim remedial system. The FS must evaluate alternatives for a permanent site remedial action.	The FS will evaluate alternatives for a permanent site remedial action.	Response acceptable.
67	"	Paragraph 5 on page 62 must be deleted. See previous comments on the development of site- specific groundwater and leaching to groundwater hot spots.	The indicated paragraph is deleted. See response to General Hot Spot Comment 2 and HHRA Comment 1.	LSS did not implement the directed changes. The paragraph is still in Section 5.3.1.
68	Section 5.4 Identification of General Response Actions, p. 63	Add a fifth bullet that reads "Any combination of the above, as appropriate".	The requested bullet is added.	Response acceptable.
69	Section 5.3.1 Preliminary Numerical RAOs, Table 5-6 Indirect Exposure Pathway for Ecological Receptors	Table 5-6 Indirect Exposure Pathway for Ecological Receptors. Table 5-6 must be updated to reflect current DEQ and EPA aquatic life criteria.	Table 5-6 is updated to reflect current DEQ and EPA aquatic life criteria. See response to General Hot Spot Comments 3 and 4.	Response acceptable. See DEQ's response to General Hot Spot Comments 3 and 4.
70	Table 5-6 Indirect Exposure Pathway for Ecological Receptors.	Table 5-6 must be updated to clearly identify which value is being used as the numerical RAO.	Table 5-6 is updated with a heading that states, "Selected Hot Spot Criterion." Per responses to previous comments, LSS intends to differentiate between "screening criteria," action levels and RAOs.	LSS did not implement the directed changes.
71	"	The correct numerical RAO for chloroform is the ORNL value of 28 µg/L. The FS Work Plan and Table 5-6 must be updated to clearly shown this.	Table 5-6 is updated to reflect current DEQ and EPA aquatic life criteria. See response to General Hot Spot Comments 3 and 4.	LSS did not implement the directed changes.
72	"	The correct numerical RAO for 1,2- Dichlorobenzene is the ORNL value of 14 µg/L. The FS Work Plan and Table 5-6 must be updated to clearly show this.	Table 5-6 is updated to reflect current DEQ and EPA aquatic life criteria. See response to General Hot Spot Comments 3 and 4.	LSS did not implement the directed changes.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment	DEQ's Response
73	Section 6.2 Remedy Selection Factors, p.66	The first sentence must be modified to read - "Each remedial action alternative assessment will be based on a balancing of the five remedy selection factors and the ability to treat or remove hot spots of contamination."	DEQ's requested language is added.	Response acceptable.
74	"	The Oregon Administrative Rule reference in the last sentence of this section must be edited to include OAR 340-122- 0090(3) and (4).	The reference to the OAR is edited.	Response acceptable.
75	6.2 Remedy Selection Factors	Remedy selection factors have been paraphrased. The FS Work Plan must include the exact OAR criteria for each of the balancing factors	The Revised FS Work Plan sections on effectiveness, long-term reliability, implementability, implementation risk and reasonableness of cost are modified to include the exact OAR criteria for each of the balancing factors.	Response acceptable.
76	Section 6.3 Preference for Treatment or Excavation of Hot Spots, p. 69	Section 6.3 must be modified to remove the sentence that reads "All remedies must be protective of present and future public health, safety and welfare and of the environment", and add it to the second sentence in Section 6.4.3 Recommended Remedial Action Alternative on page 70.	DEQ's requested language is adopted.	Response acceptable.
77	Section 6.4.2 Comparative Analysis of Alternatives, p. 70	The comparative evaluation of alternatives must also include a quantitative table in addition to text.	The comparative evaluation of alternatives will also include a quantitative table in addition to text.	Response acceptable.
78	"	Section 6.4.3 must be modified to replace the last sentence in this section with the following: "Subject to the preference for treatment of hot spots, the least expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors."	The language of the section is modified to include the substantive intent of the OARs and DEQ's guidance, consistent with the comment.	Response acceptable.
79	Section 6.4.3 Recommended Remedial Action Alternative, p. 70	The section in the FS which recommends an alternative should include the language from DEQ FS Guidance.	The Revised FS Work Plan includes, and the FS will include, language as specified in the comment and in the DEQ FS guidance.	Response acceptable.
80	Section 7.0 Reporting, page 71	Section 7.0 must be modified to delete the second bullet regarding the development of site-specific action levels in the FS.	See response to Hot Spot General Comment 2 and HHRA General Comment 1. LSS will screen for hot spots using the AWQC and assuming that constituents in groundwater are transported unattenuated to the transition zone. LSS does not agree that the same assumptions are appropriate for determining action levels in the FS and designing a remedy. The action levels to be developed in the FS and the remedial design must accommodate new data and analysis that may demonstrate attenuation from concentrations in groundwater to the transition zone.	See DEQ's response to Hot Spot General Comment 2 and HHRA General Comment 1.
81	Table 4-2 Hot Spot Receptor Pathway Evaluation	Table 4-2 must be revised to list out all individual COCs for each hot spot.	Table 4-2 is revised to list individual COCs for each hot spot.	LSS did not implement the directed changes.
82	Appendix A Revised Hot Spot Evaluation Tables and Figures.	The figure list will need to be based on the results of the revised screening using the updated/correct screening levels and data sets as directed in previous comments. For example, a figure identifying the dioxin/furan plume based on the August 2006 groundwater data must be added to Appendix A.	The Appendix A figure list is updated.	Response acceptable.

DEQ Comment No.	Draft FS Work Plan Reference	DEQ Comment (paraphrase)	Response to Comment
EPA Comments ¹			
1	General Comment	The Draft Upland FS Work Plan should identify numerical RAOs for stormwater	See response to DEQ comment 62. The Revised FS Work Plan identifies a numeric value for DEQ RAO 9. The specific RBC is the human health ambient water quality criteria for organism consumption.
2	General Comment	The Upland FS Work Plan should indicate alternatives will be developed to encompass additional general response actions for stormwater, in addition to evaluating the presumptive approach of continued implementation of the existing stormwater SCM. See additional details in comment.	See response to DEQ Comment 63. The Revised FS Work Plan states that alternatives will be developed for RAOs 9 and 10 including the existing interim system. Example alternatives will include a site-wide cap that eliminates stormwater contact with contaminated soils and associated institutional controls.
3	General Comment	The Draft Upland FS Work Plan should indicate alternatives for the riverbank will be developed to encompass a range of general response actions (including removal, disposal and/or treatment technologies). See additional details in comment.	See response to DEQ comment 6. By agreement with the DEQ, the upland FS for the riverbank will assume that the upper three feet of soil on the riverbank is a high concentration hot spot. The remedial alternatives will evaluate options to manage terrestrial ecological risk from exposure to riverbank soil, remove concrete and debris and control erodible soil.
4	General Comment	The Draft Upland FS Work Plan should include a statement confirming that as development of the Upland FS proceeds, ARARs identified for the upland work will be checked and revised as necessary for consistency with ARARs for the Harbor-wide FS process (to the degree that they have been identified and developed). Consistency for ARARs identification and evaluation in the Upland FS with the Harbor-wide FS is justified since response actions taken in the upland areas will have an impact on ARARs compliance for the in-stream portion of the Portland Harbor Superfund site.	The FS will identify ARARs identified at the time the FS is completed. ARARs for the Arkema site will include those in the Harbor-wide FS that are specifically relevant to the Arkema site.

Notes:

¹ Email from Sean Sheldrake, EPA Region 10, to Matt McClincy, 13 August 2013

Abbreviations

ARAR	applicable or relevant and appropriate requirements	HHRA	human health risk assessment
AWQC	ambient water quality criteria	LSS	Legacy Site Services LLC
COC	contaminant of concern	MCL	maximum contaminant level
COPC	chemical of potential concern	NRWQC	National Recommended Water Quality Criteria
DDD	dichlorodiphenyldichloroethane	OAR	Oregon Administrative Rule
DDE	dichlorodiphenyldichloroethylene	ORNL	Oak Ridge National Laboratory
DDT	dichlorodiphenyltrichloroethane	RAO	remedial action objective
DDx	sum total of DDD, DDE, and DDT	RBDM	Risk-Based Decision Making
DEQ	Oregon Department of Environmental Quality	RP	Rhone Poulenc
D/F	dioxins and furans	RD/RA	remedial design/remedial action
EPA	U.S. Environmental Protection Agency	SCM	source control measure
FS	feasibility study	TCDD	tetrachlorodibenzo-p-dioxin
GW	groundwater	µg/L	microgram per liter
HSE	hot spot evaluation	WQC	water quality criteria
IRM	interim remedial measure		